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Behavioral Traps in Flight Crew-Related 14 CFR Part 121 Airline Accidents

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BEHAVIORAL TRAPS IN FLIGHT CREW-RELATED 14 CFR PART 121 AIRLINE ACCIDENTS

by

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in Partial Fulfillment of the Requirements for the Degree of
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This Dissertation was prepared under the direction of the candidate's Dissertation Committee Chair, Dr. Tim Brady, Chancellor, Daytona Beach Campus; and Dissertation Committee Members Dr. Andrew R. Dattel, Assistant Professor, Daytona Beach Campus; Dr. Dennis A. Vincenzi, Professor, Worldwide Campus; and Dr. Paul A. Craig, External Member, and has been approved by the Dissertation Committee. It was submitted to the College of Aviation in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Aviation

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ABSTRACT

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This dissertation examined pilot behavioral traps in the multi-crew Part 121 air carrier environment. Behavioral traps are accident-inducing operational pitfalls aviators may encounter as a result of poor decision making. The traps studied were: Loss of Situational Awareness; Neglect of Flight Planning, Preflight Inspections and Checklists; Peer Pressure; Get-There-Itis; and Unauthorized Descent Below an Instrument Flight Rule (IFR) Altitude. The purpose of this dissertation was to study the nature of their occurrence in the airline domain. Another key component was to explore the relationships between the behavioral traps and factors such as pilot age, pilot flight experience, weather, flight conditions, time of day, and the first officer certification level.

The dissertation was conducted using an archival combined-methods methodology. Four subject matter experts analyzed 34 National Transportation Safety Board (NTSB) accident reports. Behavioral traps were found in all accidents with Loss of Situational Awareness and Neglect of Flight Planning, Preflight Inspections, and Checklists dominant. The SMEs were able to identify many pilot actions that were representative of the behavioral traps.

During the qualitative analysis, various themes began to emerge which played important roles in many accidents. These emerging themes were Crew Resource Management issues, Fatigue, Airline Management, and Flying Outside the Envelope. The quantitative analysis discovered a moderate correlation, $r = -.34$, $p = .05$, between the Captain's Flight Experience and the behavioral trap Unauthorized Descent Below an IFR Altitude. No other correlations were found to be significant between the variables and the behavioral traps. The findings of this study indicated that behavioral traps were prevalent in airline accidents including habitual noncompliance by pilots. Further research should focus on other flight domains and other informational sources such as air taxi operators, incident accounts, and flight recorded data. Attitude management training is recommended.

DEDICATION

My journey to a doctoral degree began more than four years ago. This dissertation is dedicated to Amos. I trust the time and effort spent completing this manuscript was part of your plan. With your guidance, everything is possible.

To my parents, Israel Velázquez and Sonia I. Rivera, who inspired me to persevere and pursue the highest goals in life. Without their moral and financial support, the road and destination would have been different.

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CHAPTER I

INTRODUCTION

This study examined pilot behavioral traps in the multi-crew Part 121 air carrier environment. Behavioral traps may be evidence of human error and poor decision making. Approximately three out of four airplane accidents result from human error (Broome, 2011). The Federal Aviation Administration (FAA) conducts research on human error in an effort to understand how people behave in a variety of situations. Studying human behavior in aviation can help mitigate the rate of accidents due to human error. Research on aviator actions in the cockpit led to the discovery of various unsafe pilot behaviors some called hazardous attitudes and others behavioral traps (FAA, 2009).

Unsafe pilot behaviors have been of interest to the FAA for many years (FAA, 1991; FAA, 2004; FAA, 2008; FAA, 2009). The FAA has termed some of these behaviors as hazardous attitudes, and they are categorized as: Macho, Anti-authority, Impulsivity, Resignation, and Invulnerability (FAA, 2009). Other pilot behaviors are named operational pitfalls or behavioral traps. In addition to the five hazardous attitudes, these accident-inducing qualities are: Peer Pressure; Mind Set, Get-There-Itis; Duck-Under Syndrome; Scud Running; Continuing Visual Flight Rules (VFR) into Instrument Conditions; Getting Behind the Aircraft; Loss of Positional/Situational Awareness; Operating Without Adequate Fuel Reserves; Descent Below the Minimum En Route Altitude (MEA); Flying Outside the Envelope; and Neglect of Flight Planning, Preflight Inspections, and Checklists. In order to assist pilots in managing these behaviors, in 1991 the FAA published the Advisory Circular (AC) 60-22 named Aeronautical Decision Making (ADM), commonly known as the ADM manual.

The FAA defines ADM as the organized approach to the mental process used by pilots to unfailingly attain the best course of action given a set of circumstances (FAA, 2008). Poor decision making skills can lead to error or accidents. According to the FAA (2009), the first two steps of ADM are "(1) identifying personal attitudes hazardous to safe flight and (2) learning behavior modification techniques" (p. 5-3). During single-pilot operations, aviators may use AC 60-22 as a guide to identify personal attitudes that are unsafe for flying. During multi-crew operations, pilots may refer to AC 120-51e, Crew Resource Management (CRM) training (FAA, 2004), for further guidance.

CRM is the effective use of all available resources for commercial flight crews to ensure a safe and resourceful operation while at the same time reducing error and increasing efficiency. Helmreich and Foushee (1993) gathered statistics on commercial aviation accidents from 1959 to 1989 and found that human errors of flight crews were the cause in more than 70% of accidents. The understanding of pilot attitudes and their role in team dynamics or impact on CRM still requires further research (Salas, Shuffler, & Diaz, 2010). It is generally accepted that personality has an influence on behavior and that this, in turn, places an individual at greater or less risk of accident involvement (Hunter, 2005), despite the fact an *accident inclined* personality type has been difficult to establish (Grey, Triggs, & Haywarth, 1989; McKenna, 1988). The study of unsafe pilot attitudes has extended many decades (Casner, 2010; Hunter, 2005; Lester & Bombaci, 1984; Mosier et al., 2012; Murray, 1999; Shappell et al., 2007); however, much of the research has been limited to the general aviation (GA) domain and to the five classical hazardous attitudes (Berlin et al., 1982; Kaempf & Klein, 1994; Stewart, 2008; Wetmore & Lu, 2006).

Significance of the Study

This study sought to reveal the presence of behavioral traps in the FAR Part 121 airline domain. The study leads to a greater understanding of how behavioral traps affect team dynamics in the cockpit and a specific understanding of how behavioral traps affect aeronautical decision making and ultimately flight safety. In addition, knowledge of these behavioral traps in crews can influence portions of CRM training to include hazardous behavior identification and modification techniques.

Statement of the Problem

Various studies have suggested the presence of many unsafe pilot attitudes during airplane accidents and the existence of personality factors that impair judgment. However, no published study had directly examined the presence of behavioral traps within crew operated flights. Instead, studies concerning unsafe pilot behavior have been mostly limited to the single-pilot and/or the GA domain. CRM training has helped reduce the presence of *lone wolves* or individuals who are self-reliant, technically competent, and slightly narcissistic in their own capacities (Foushee, 1984). However, in our attempt to reduce the rate of accidents, it is important that researchers continue to explore how aircrews are impacted by the individual differences that their group members bring to the table (Salas et al., 2010). This exploration includes the aeronautical decision making of crews.

Poor decision making can be a harbinger of behavioral traps and increase the likelihood of an aviation accident. Examples of behavioral traps include the pressure to complete a flight as planned, the desire to please passengers or to meet schedules, and the determination to *get the job done* (FAA, 2009). Studies have suggested the presence of these dangerous attitudes during airplane accidents (Dismukes, Berman, & Loukopoulos, 2007; Drinkwater & Molesworth, 2010; O'Hare & Wiegmann, 2003; Veillette, 2006; Wetmore, Bos, & Lu, 2007).

Purpose Statement

This study examined pilot behavioral traps in the multi-crew, Part 121 air carrier environment. By examining the behavioral traps, the products of this research provide a greater understanding of how aircrews deal with attitudes or pilot behaviors that threaten flight safety. Wetmore and Lu (2006) explained that their inquiry of pilot hazardous attitudes had only focused on Part 91 operations; they posited that because pilots will begin their flying careers in the GA domain, their initial study should also focus on that segment of the population. Although their plans were to continue to Part 135 and 121 operations, no further examination was accomplished in these areas. It is the investigation of factors that influence the cognition and behavior of people that helps researchers and trainers find useful ways to change systems in order to reduce the potential for disaster (Woods, Dekker, Cook, Johannesen, & Sarter, 2010).

A close examination of the original 12 behavioral traps reveals that many of them are not applicable to the environment of a Part 121 airline – specifically, Scud Running, Continuing VFR Flight into Instrument Conditions, Operating Without Adequate Fuel Reserves, and Flying Outside the Envelope. Thus, the following behavioral traps will be studied: Loss of Situational Awareness; Neglect of Flight Planning, Preflight Inspections, and Checklists; Peer Pressure; Get-There-Itis; and Unauthorized Descent Below an IFR Altitude. These behavioral traps are applicable to the Part 121 air carrier environment. These include behaviors that share common definitions with each other (Descent Below the MEA is similar to Duck-Under Syndrome, and Loss of Positional/Situational Awareness is similar to Getting Behind the Aircraft). In addition, some of these behavioral traps involve direct pilot action (Duck-Under-Syndrome and Operating Without Adequate Fuel Reserves) while others encompass more cognitive attitudes (Peer Pressure and Mind Set).

Jeppesen (2014) classified the behavioral traps as instrument operating, commercial operating, or single-pilot/general aviation. This study used Jeppesen's commercial and instrument behavioral traps. In addition, there are only two Jeppesen (2014) instrument behavioral traps that involve the same action; both Duck-Under Syndrome and Descending Below the MEA consist of going below an authorized altitude during an IFR flight. For the purposes of this study, the two were combined into a new classification termed *Unauthorized Descent Below an IFR Altitude.*

In summary, this research studied the following behavioral traps: Loss of Situational Awareness (SA); Neglect of Flight Planning, Preflight Inspections, and Checklists; Peer Pressure; Get-There-Itis; and Unauthorized Descent Below an IFR Altitude, as these behavioral traps are applicable to the Part 121 air carrier environment. A group of four subject matter experts (SMEs) standardized the classification of the behavioral traps during the initial portion of the analysis. This standardized classification of behavioral traps will preclude confusion with unnecessary overlap when studying similarly defined behavioral traps.

Research Questions and Hypotheses

This study aimed to determine the frequency of behavioral traps occurring in crew-related aviation accidents. The specific research questions of this study were:

1. Which behavioral traps are present in Part 121 accidents?
2. With what frequency do behavioral traps occur in Part 121 accidents?
3. How are behavioral traps manifested in flight crew-related accidents?
4. What relationships exist between the pilot behavioral traps and factors such as age, flight experience, weather, flight conditions, time of day, and first officer certification level?

The research hypotheses stated that there was a relationship among the behavioral traps and the factors mentioned above. The null hypotheses were:

$H_0$1: There was no relationship between a captain's age and the following behavioral traps:

a) Loss of Situational Awareness

b) Neglect of Flight Planning, Preflight Inspections, and Checklists

c) Peer Pressure

d) Get-There-Itis

e) Unauthorized Descent Below an IFR altitude

$H_0$2: There was no relationship between a captain's flight experience (hours flown) and the following behavioral traps:

a) Loss of Situational Awareness

b) Neglect of Flight Planning, Preflight Inspections, and Checklists

c) Peer Pressure

d) Get-There-Itis

e) Unauthorized Descent Below an IFR Altitude

$H_0 3$: There was no relationship between a first officer's age and the following behavioral traps:

a) Loss of Situational Awareness

b) Neglect of Flight Planning, Preflight Inspections, and Checklists

c) Peer Pressure

d) Get-There-Itis

e) Unauthorized Descent Below an IFR Altitude

$H_0 4$: There was no relationship between a first officer's flight experience (hours flown) and the behavioral traps known as:

a) Loss of Situational Awareness

b) Neglect of Flight Planning, Preflight Inspections, and Checklists

c) Peer Pressure

d) Get-There-Itis

e) Unauthorized Descent Below an IFR Altitude

$H_0 5$: There was no relationship between a first officer's certification level (commercial versus airline transport pilot) and the following behavioral traps:

a) Loss of Situational Awareness

b) Neglect of Flight Planning, Preflight Inspections, and Checklists

c) Peer Pressure

d) Get-There-Itis

e) Unauthorized Descent Below an IFR Altitude

$H_0$6: There was no relationship between inclement weather and the following behavioral traps:

a) Loss of Situational Awareness

b) Neglect of Flight Planning, Preflight Inspections, and Checklists

c) Peer Pressure

d) Get-There-Itis

e) Unauthorized Descent Below an IFR Altitude

$H_0$7: There was no relationship between flight conditions (instrument meteorological conditions (IMC) versus visual meteorological conditions (VMC) and the behavioral traps known as:

a) Loss of Situational Awareness

b) Neglect of Flight Planning, Preflight Inspections, and Checklists

c) Peer Pressure

d) Get-There-Itis

e) Unauthorized Descent Below an IFR Altitude

$H_0$8: There was no relationship between time of day (day versus night) and the behavioral traps known as:

a) Loss of Situational Awareness

b) Neglect of Flight Planning, Preflight Inspections, and Checklists

c) Peer Pressure

d) Get-There-Itis

e) Unauthorized Descent Below an IFR Altitude

Delimitations

This study focused on the behavioral traps displayed during U.S. aviation accidents of 14 CFR Part 121 air carrier operations. Foreign or international accidents were excluded from the analysis, as were accidents classified as having undetermined causes and those that were attributed to sabotage, suicide, or criminal activity such as hijacking. This research drew from U.S. aviation accidents attributed to flight crew error from 1991 to 2013. For the purpose of this study, the factual reports and subsequent Aviation Accident Reports (AARs) from the National Transportation Safety Board (NTSB) were used to explore exclusively commercial Part 121 flight crew-related accidents. Also, excluded from this analysis were the incidents and accidents from Part 135 commercial operations.

Limitations and Assumptions

The FAA-defined behavioral traps also presented somewhat of a challenge to the study. As stated earlier, some of these behavioral traps involve direct pilot action (Duck-Under Syndrome and Operating Without Adequate Fuel Reserves) while others encompass more cognitive attitudes (Peer Pressure and Mind Set). In addition, some behavioral traps, such as Continuing VFR into Instrument Conditions might not be applicable to the operating environment of a 14 CFR Part 121 air carrier. Three strategies were used to handle this situation: (1) the categorization provided by Jeppesen (2014) where the behavioral traps are classified as either instrument operating, commercial operating, or single-pilot/general aviation, operating behavioral traps were used, (2) the

SMEs were aware of these classifications and alerted before entering the coding process, and (3) the SMEs employed a developed set of guidelines and descriptors used during a pilot study of behavioral traps by Velazquez, Peck, and Sestak (2015) to identify and classify pilot actions as behavioral traps. These examples also assisted the SMEs when identifying the behavioral traps and the underlying human factors issues surrounding them. These solutions, along with the applicable FAA definitions, provided the SMEs with an adequate coding scheme.

Definition of Terms

14 CFR Part 121	Part 121 within Title 14 of the Code of Federal Regulations which contains the operating requirements for domestic, flag, and supplemental air carrier operations (FAA, 2016).
Accident	"An occurrence associated with the operation of an aircraft that takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage" (Transportation, 2016).
Aeronautical decision making	"A systematic approach to the mental process used consistently by pilots to determine the best course of action in response to a given set of

	circumstances. It is what a pilot intends to do based on the latest information he or she has" (FAA, 2009, p. G-1).
Aircraft	Device that is used or intended to be used for flight in the air (FAA, 2016).
Airport/Facility Directory	"An FAA publication containing information on all airports, communications, and NAVAIDs" (FAA, 2009, G-1).
Attitude	"A learned and relatively enduring perception, expressed or unexpressed, influencing a person to think or behave in a fairly predictable manner toward objects, persons, or situations" (Wilkening, 1973, p. 28).
Attitude management	"The ability to recognize hazardous attitudes in oneself and the willingness to modify them as necessary through the application of an appropriate antidote thought" (FAA, 2009, p. G-1).
Autopilot	"An automatic flight control system that keeps an aircraft in level flight or on a set course. Automatic pilots can be directed by the pilot, or they may be coupled to a radio navigation signal" (FAA, 2009, p. G-1).

Behavioral Traps	Also called operational pitfalls, these are unsafe pilot behaviors or tendencies that dangerously affect flight safety by hindering aeronautical decision making and judgment.
Checklist	“A tool that is used as a human factors aid in aviation safety. It is a systematic and sequential list of all operations that must be performed to accomplish a task properly” (FAA, 2009, p. G-1).
Controlled Flight into Terrain	“An accident whereby an airworthy aircraft, under pilot control, inadvertently flies into terrain, an obstacle, or water” (FAA, 2009, p. G-1).
Course	“The intended direction of flight in the horizontal plane measured in degrees from north” (FAA, 2009, p. G-1).
Crew Resource Management	Effective use of all available resources by air crew personnel to assure a safe and efficient operation, reduce error, reduce stress, and increase efficiency of flight operations. It is predicated upon good operating practices such as open communication, leadership, following checklists and standard operating procedures (SOPs), conducting good preflight action, and engaging in proper flight

	planning to prepare for unexpected events during flight (FAA, 2004).
Decision Altitude	“A specified altitude in the precision approach, charted in feet MSL, at which a missed approach must be initiated if the required visual reference to continue the approach has not been established” (FAA, 2009, G-2).
Decision Height	“A specified altitude in the precision approach, charted in height above threshold elevation, at which a decision must be made either to continue the approach or to execute a missed approach” (FAA, 2009, p. G-2).
Emergency	A distress or urgent condition (FAA, 2009).
External Pressures	“Influences external to the flight that create a sense of pressure to complete a flight—often at the expense of safety” (FAA, 2009, G-2).
Federal Aviation Administration	“An agency of the United States Department of Transportation with authority to regulate and oversee all aspects of civil aviation in the United States” (FAA, 2009, p. G-2).
Flight Path	“The line, course, or track along which an aircraft is flying or intended to be flown” (FAA, 2009, G-1).

General Aviation	“All flights other than military and scheduled airline flights, both private and commercial” (FAA, 2009, G-1).
Hazardous Attitudes	“Five aeronautical decision-making attitudes that may contribute to poor pilot judgment: Anti-authority, Impulsivity, Invulnerability, Macho, and Resignation” (FAA, 2009, p. G-3).
Human behavior	“The product of factors that cause people to act in predictable ways” (FAA, 2009, p. G-3).
Human Factors	“A multidisciplinary field encompassing the behavioral and social sciences, engineering, and physiology, to consider the variables that influence individual and crew performance for the purpose of optimizing human performance and reducing errors” (FAA, 2009, G-3).
Incident	“An occurrence other than an accident that affects or could affect the safety of operations” (Transportation, 2016).
Instrument Flight Rules	“Rules and regulations established by the Federal Aviation Administration to govern flight under conditions in which flight by outside visual reference is not safe. IFR flight depends upon flying by reference to instruments in the flight deck,

	and navigation is accomplished by reference to electronic signals" (FAA, 2009, p. G-3).
Instrument Conditions	Also known as Instrument Meteorological Conditions, these are weather circumstances expressed in terms of visibility, distance from clouds, and ceiling less than the minimums specified for visual meteorological conditions, requiring operations to be conducted under IFR (FAA, 2009).
Judgment	"The mental process of recognizing and analyzing all pertinent information in a particular situation, a rational evaluation of alternative actions in response to it, and a timely decision on which action to take" (FAA, 2009, p. G-3).
Notice to Airmen	"A notice filed with an aviation authority to alert aircraft pilots of any hazards en route or at a specific location. The authority in turn provides means of disseminating relevant NOTAMs to pilots" (FAA, 2009, p. G-3).
Personality	"The embodiment of personal traits and characteristics of an individual that are set at a very early age and extremely resistant to change" (FAA, 2009, p. G-4).

Pilot error	“An accident in which an action or decision made by the pilot was the cause or a contributing factor that led to the accident” (FAA, 2009, p. G-4).
Pilot in command	“The pilot responsible for the operation and safety of an aircraft” (FAA, 2009, p. G-4). This person is the captain during crew operations.
Poor judgment chain	A series of mistakes or chain of events that may lead to an accident or incident. “Two basic principles generally associated with the creation of a poor judgment chain are: (1) one bad decision often leads to another; and (2) as a string of bad decisions grows, it reduces the number of subsequent alternatives for continued safe flight”(FAA, 2009, p. G-4).
Situational Awareness	“Knowledge of where the aircraft is in regard to location, air traffic control, weather, regulations, aircraft status, and other factors that may affect flight” (FAA, 2009, p. G-4).
Substantial Damage	Damage or failure which adversely affects the structural strength, performance, or flight characteristics of the aircraft, and which would normally require major repair or replacement of the affected component. Engine failure or damage

	limited to an engine if only one engine fails or is damaged, bent fairings or cowling, dented skin, small punctured holes in the skin or fabric, ground damage to rotor or propeller blades, and damage to landing gear, wheels, tires, flaps, engine accessories, brakes, or wingtips are not considered "substantial damage" for the purpose of this part (Transportation, 2016).
Title 14 of the CFR	"Includes what was formerly known as the Federal Aviation Regulations governing the operation of aircraft, airways, and airmen" (FAA, 2009, p. G-4).
Visual Flight Rules	"Flight rules adopted by the FAA governing aircraft flight using visual references. VFR operations specify the amount of ceiling and the visibility the pilot must have in order to operate according to these rules. When the weather conditions are such that the pilot cannot operate according to VFR, he or she must use instrument flight rules (IFR)" (FAA, 2009, p. G-5).

List of Acronyms

AAR	Aviation accident reports
AC	Advisory Circular

ADM	Aeronautical decision making
ASAS	Aviation Safety Attitude Scale
ASRS	Aviation Safety Reporting System
ATP	Airline transport pilot
CFI	Certified flight instructor
CFII	Certified flight instructor-instrument
COM	Continental Operations Manual
CFR	Code of Federal Regulations
CRM	Crew resource management
CVR	Cockpit voice recorder
DA	Decision altitude
DH	Decision height
DIT2	Defining issues test 2
HB/CF	Hazardous behaviors/causal factors
DOT	Department of Transportation
ERAU	Embry-Riddle Aeronautical University
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FIT	Florida Institute of Technology
FO	First Officer
FOM	Flight Operations Manual
FPM	Feet per minute
GA	General aviation

GPS	Global Positioning System
IFR	Instrument flight rules
ILS	Instrument landing system
IMC	Instrument meteorological conditions
LOFT	Line-Oriented flight crew
MDA	Minimum decent altitude
MEA	Minimum en route altitude
MEI	Multi engine instructor
N-HAS	New Hazardous Attitudes Scale
NOTAM	Notice to Airmen
NTSB	National Transportation Safety Board
Part 91	14 CFR Part 91 General Operating and Flight Rules
Part 135	14 CFR Part 135 Commuter/On-demand Operations
Part 121	14 CFR Part 121 Airline Operations
PIC	Pilot in command
QRH	Quick Reference Handbook
SPSS	Statistical Package for the Social Sciences
SA	Situational awareness
SME	Subject matter expert
SOP	Standard operating procedure
TEM	Threat and error management
VFR	Visual flight rules
VMC	Visual meteorological conditions

CHAPTER II

REVIEW OF THE RELEVANT LITERATURE

Researchers have studied unsafe pilot behaviors for several decades (Casner, 2010; Hunter, 2005; Lester & Bombaci, 1984; Murray, 1999). The studies have focused mostly on hazardous attitudes, risky behaviors, and pilot cognitive biases, all of which could impair judgment. Because the behavioral traps have not all been directly studied within the commercial Part 121 domain, this chapter will review important studies on hazardous attitudes, pilot cognitive biases, CRM, and Threat and Error Management (TEM) and exhibit how each relate to the study of behavioral traps.

Understanding Hazardous Attitudes

The study of hazardous attitudes in aviation began in the early 1980s at Embry-Riddle Aeronautical University (ERAU) as a direct outcome of the late 1970s work on pilot decision making from Jensen and Benel (Martinussen & Hunter, 2010). Berlin et al. (1982) developed a training curriculum that addressed judgment and decision making. Berlin found that physiological, psychological, and external pressures influence every decision a pilot makes. The study also found that a need for a pilot to maintain a self-image can impair pilot judgment. One of the results of Berlin et al. was the identification of the hazardous attitudes. Table 1 describes the five hazardous attitudes and provides the recommended antidote used to counteract each one. The application of the antidote is possible only after a pilot has been able to first recognize the presence of the hazardous attitude.

Table 1

Overview of Hazardous Attitudes with the Appropriate Antidote

Attitude	Characteristics	Antidote
Anti-authority	Pilots with this attitude dislike following the rules or having someone else tell them what to do. To these pilots, rules and procedures are a waste of time and effort.	"Follow the rules; they are usually right."
Impulsivity	This attitude belongs to pilots who feel they must do something, anything, and immediately. They seldom take a moment to reflect or evaluate all the possibilities. Their actions are the result of whatever comes first to mind.	"Not so fast; think first."
Macho	Macho pilots are risk takers, people overconfident about their skills and constantly proving that they are better than everybody else. To them, they are the best pilots out there.	"Taking chances is foolish"
Invulnerability	Similar to Macho-type pilots, these pilots also take risks but only because in their mind accidents happen to others and not to them.	"It could happen to me."
Resignation	People with this attitude feel they are incapable of making a difference. Pilots with Resignation-type attitudes are passive and inactive throughout their flights. To these pilots, when something bad happens it is due to bad luck or the fault of others; someone else is responsible.	"I am not helpless; I can make a difference."

Note. Adapted from Jeppesen, 2013, p. 10-31.

Research on Hazardous Attitudes

The FAA (1991) developed a hazardous inventory test to assist pilots in identifying their own hazardous attitudes. Hunter (2005) proposed two new hazardous attitudes measurement tests as an alternative to the first one developed by the FAA. Hunter's two new tests specifically addressed the relationship of the hazardous attitudes to accident involvement. These were the Aviation Safety Attitude Scale (ASAS), a scale originally administered as part of a national probability sample survey of pilots (Hunter, 1995) and the New Hazardous Attitudes Scale (N-HAS), originally developed by Holt, Boehm-Davis, Fitzgerald, Matyuf, Baughman, and Littman (1991).

The ASAS measures the pilot's attitude regarding safety issues. The test items reflect the five hazardous attitudes suggested by Berlin et al. (1982) and attitudes concerning weather, the risks encountered in aviation, the likelihood of experiencing an accident, and self-perceived skill or confidence. On the other hand, the N-HAS consists of simple declarative statements with a Likert-type response scale. Initially developed for the measurement of driver attitudes, researchers determined that the N-HAS contained factors that generally corresponded to four of the hazardous attitudes (Macho, Impulsivity, Anti-authority, and Resignation).

Wetmore and Lu (2005a; 2005b; 2006) added extensively to the understanding of how hazardous attitudes affect decision making and risk management. Wetmore, Bos, and Lu (2007) conducted a case-based analysis for civil aviation accidents using the five hazardous attitude categories as criteria. The analysis revealed that, similar to previous research using GA pilots, Invulnerability was the most prevalent hazardous attitude associated with 80% of the flight instructors involved in accidents. Wetmore and Lu (2006) studied fatal general aviation accidents and found that an increase in hazardous attitudes led to greater risk taking, poorer decision making, and a reduction in use of resources, three very important skills in CRM. In addition, hazardous attitudes were a contributing factor in 86% of general aviation accidents that involved a fatality (Wetmore & Lu, 2006). Wetmore & Lu (2005a) found that pilot age does not correlate to hazardous attitudes. Finally, advanced pilot certificates and flight experience each correlate to a reduction in hazardous attitudes (Wetmore & Lu, 2005b). This finding seems intuitive because generally pilots with more experience should be able to identify and mediate their hazardous attitudes.

Personality can play a large part in the manner in which hazards are appraised. Veillette (2006) debated the possibility of an accident-prone pilot and found that pilots fitting into this category exhibited five traits closely linked to the original five hazardous attitudes. These were:

> (1) disdain toward rules, (2) high correlation between accidents in their flying records and safety violations in their driving records, (3) frequently falling into the personality category of *thrill and adventure seeking*, (4) impulsive rather than methodical and disciplined in information gathering and in the speed and actions taken, and (5) disregard for or underutilization of outside sources of information, including copilots, flight attendants, flight service station personnel, flight instructors, and air traffic controllers. (FAA, 2009, p. 2-4)

Each of the previously mentioned traits somewhat correspond to the five hazardous attitudes: (1) Anti-authority, (2) Macho, (3) Invulnerability, (4) Impulsivity, and (5) Resignation.

The Possibility of a Sixth Hazardous Attitude

Murray (1999) suggested a sixth hazardous attitude called *Fear of Loss of Face*. According to Goffman (1955), face is the “positive social value a person effectively claims for himself by the line others assume he has taken during a particular contact" (p. 213). In other words, it is the interpretation a person has about how others view him or her. When a person assumes a self-image, expressed as face, he or she will attempt to maintain that face or image using the following strategies (p. 404):

- Avoiding the initiation of social contacts and seeking the safety of solitude (Goffman, 1955, 1967).
- Sacrificing tangible rewards to avoid looking foolish (Brown & Garland, 1971).
- The concealing of anxieties, to avoid being ridiculed or censured (Brown, 1970).
- In extreme cases, retreating permanently from potential face-losing situations and even committing suicide (Bond & Hwang, 1986).

Fear of Loss of Face has been recognized to have potential negative effects on human behavior (Murray, 1999). When a person is embarrassed or looks foolish they have experienced a Loss of Face. Murray argues that, at the individual level, Fear of Loss of Face is exemplified when a pilot receives a perplexing ATC instruction and prefers to remain silent to avoid being judged as incompetent. At the group level, aviation crews are looked at as good communities, and any person who casts uncertainties or has doubts may be shamed or ridiculed. This can be used as another example of Fear of Loss of Face at the group level. Murray called for more research and a revision of the five hazardous attitudes, originally developed at ERAU, to include Fear of Loss of Face. The author argued that in a multi-crew cockpit Loss of Face may be the most critical factor during CRM. Despite Murray's interesting study, no further inquiry was made in this topic.

It was not the first time a revision to the hazardous attitudes was recommended. In the late 1980s, Telfer proposed *Deference* (1987, 1989) as another hazardous attitude. Unfortunately, according to Murray (1999), Deference holds close relationship with the fifth hazardous attitude called Resignation. As defined, Deference referred to pilots who surrender to pressure in an attempt to conform to their peers or to authority (1999).

Validating the Hazardous Attitudes

The validity of the original hazardous attitudes and the way they were initially derived has raised questions with a few researchers.

> Lester and Bombaci (1984) claimed that the five hazardous attitudes identified in the ERAU studies were not based on empirical data but on the ad hoc contributions of expert opinions. Their validation study and subsequent studies by Lester and Connolly (1987) and Lubner and Markowitz (1991) cast some doubt on the validity of the hazardous attitudes concept and suggested the need for further research. (Murray, 1999, p. 407)

Lester and Bombaci (1984) also found that the majority of general aviation pilots who exhibit hazardous attitudes fall into the attitude of Invulnerability (43%) followed by Impulsivity (20%) and Macho (14%). No participants fell into the remaining two categories. Lester and Connolly (1987) similarly found that the predominant hazardous thought pattern was Invulnerability (39%) followed by Impulsivity (24%) and finally Macho (19%). Resignation and Anti-authority response patterns did not emerge. Lester and Connolly suggested that the hazardous attitude of Anti-authority may be symptomatic or a behavior overlapping with that of other attitudes, such as Invulnerability or Macho (Murray, 1999).

Despite the criticism of the conception of the hazardous attitudes, the FAA and many organizations have noted positive safety outcomes when decision making training includes the hazardous attitudes concepts (Diehl, 1991; FAA, 1991). For example, Diehl and Lester (1987) conducted a survey after students at ERAU had undergone a six week course on decision making training with the hazardous attitudes. The survey results indicated that 56% of students said that their decision making skills had improved; 80% of the same group recommended inserting the course in the flight training syllabus (Cook, 2002). Archival research using accident reports is necessary to continue exploring the hazardous attitudes, their validity, and their relationship to other factors such as age (Stewart, 2006).

Defining Behavioral Traps

Similar to the hazardous attitudes are behavioral traps as described in the FAA's (2009) Risk Management Handbook. Behavioral traps are operational pitfalls aviators may encounter as a result of poor decision making. These 12 accident-inducing behaviors are defined in Table 2. Veteran aviators have experienced or encountered one or more of these behaviors in their flying professions (FAA, 1991). Behavioral traps include the pressure to complete a flight as planned, the desire to please passengers or to meet schedules, and the determination to *get the job done* (FAA, 2009).

Table 2

Overview of Behavioral Traps

Behavioral Trap	Definition
Peer Pressure	Poor decision-making may be based upon an emotional response to peers, rather than evaluating a situation objectively.
Mind Set	A pilot displays Mind Set through an inability to recognize and cope with changes in a given situation.
Get-There-Itis	This disposition impairs pilot judgment through a fixation on the original goal or destination, combined with a disregard for any alternative course of action.
Duck-Under Syndrome	A pilot may be tempted to make it into an airport by descending below minimums during an approach. A pilot may believe that there is a built-in margin of error in every approach procedure, or a pilot may not want to admit that the landing cannot be completed and a missed approach must be initiated.
Scud Running	This occurs when a pilot tries to maintain visual contact with the terrain at low altitudes while instrument conditions exist.
Continuing Visual Flight Rules (VFR) into Instrument Conditions	Spatial disorientation or collision with ground/obstacles may occur when a pilot continues VFR into instrument conditions. This can be even more dangerous if the pilot is not instrument rated or current.
Getting Behind the Aircraft	This pitfall can be caused by allowing events or the situation to control pilot actions. A constant state of surprise at what happens next may be exhibited when the pilot is getting behind the aircraft.
Loss of Positional / Situational Awareness	In extreme cases, when a pilot gets behind the aircraft, a loss of positional or situational awareness may result. The pilot may not know the aircraft's geographical location or may be unable to recognize deteriorating circumstances.
Operating Without Adequate Fuel Reserves	Ignoring minimum fuel reserve requirements is generally the result of overconfidence, lack of flight planning, or disregarding applicable regulations.
Descent Below the Minimum En Route Altitude	The Duck-Under Syndrome, as mentioned above, can also occur during the en route portion of an Instrument Flight Rules (IFR) flight.

Flying Outside the Envelope	The assumed high-performance capability of a particular aircraft may cause a mistaken belief that it can meet the demands imposed by a pilot's overestimated flying skills.
Neglect of Flight Planning, Preflight Inspections, and Checklists	A pilot may rely on short- and long-term memory, regular flying skills, and familiar routes instead of established procedures and published checklists. This can be particularly true of experienced pilots.

Note. As defined by the FAA (2008, p. 9-12)

Expanding on the Definitions of Behavioral Traps

This section will expand on the FAA definition of the behavioral traps. Following these definitions, relationships will be determined between the behavioral traps and other undesirable pilot conducts such as hazardous attitudes (Table 3), cognitive biases (Table 4), and TEM Errors (Table 5). By illustrating the associations between these harmful behaviors, the reader will be able to understand the many damaging pilot actions. These relationships have been carefully gleaned from the literature and were synthesized from the collected works but have not been tested. Table 6, at the end of the chapter, will summarize these associations.

Peer Pressure. To function safely in the aviation setting, pilots must understand how peers impact decision making. Peers are important social components of life. However, friends, colleagues, and associates may cloud judgment. The desire to conform to others, to be accepted, and to be right are fundamental needs of human beings. Peer Pressure can be obvious or subtle, verbal or non-verbal, intentional or unintentional, and its origin may be personnel or organizational (Kern, 1998). Peer Pressure is a behavioral trap that affects decision making.

Mind Set. Pilots are individuals of extreme focus and commitment (Landsberg, 2009). Continuous training and certification processes, especially in the commercial aviation environment, require these traits. Mind Set is sometimes called mental expectancy. A pilot exhibits Mind Set through a failure to identify and manage changes in a situation unlike what was anticipated or planned. Research has shown that because people make inferences in harmony with their hopes, wishes, and desires (Green, Muir, James, Gradwell, & Green, 1996), once a person has formulated a way of thinking about a problem, it appears difficult for him or her to get out of that way of thinking and try a different approach

Get-There-Itis. Pilots are mission oriented. The behavioral trap known as Get-There-Itis or *Get-Home-Itis* occurs when mission accomplishment is placed above safety. This trap happens due to many external factors such as home sickness or the prospect of an early work departure (Kern, 1998). A pilot's desire to complete the flight gets stronger as the person nears the destination. Get-There-Itis may be illustrated by a disregard of alternate airports or a refusal to abort a landing. Also, Dismukes et al. (2007) argues that the behavioral trap of Peer Pressure can lead to Get-There-Itis.

> Pressure to maintain scheduled arrival time might conceivably lead flight crews to make less conservative decisions and, in particular, might contribute to plan continuation errors [Get-There-Itis] such as failure to discontinue an approach when it becomes inappropriate/dangerous to do so. (p. 280)

Duck-Under Syndrome and Descent Below the MEA. The behavioral trap known as Duck-Under Syndrome occurs during flight under IFR. During instrument approaches to an airport, a pilot in IMC should only descend to a height called minimum descent altitude (MDA) or decision altitude (DA) before he/she makes a final determination to land or abort the approach. Some pilots may reveal a tendency to *take a sneak peek* by descending below these minimums during an approach. This inclination may be based on a false belief that there is always a built-in safety factor that can be used or on an unwillingness to abort a landing. Descent below the MEA is very similar but occurs during the en route phase of flight, whereas Duck-Under Syndrome occurs during an approach to an airport.

Scud Running. Scud Running means the pilot deliberately flies under low clouds while attempting to maintain visual contact outside the airplane. There are many risks associated with this activity: flight into unseen obstructions or terrain (such as towers or power lines), loss of aircraft control, forced landings, getting lost, or inadvertent flight into IMC (Wischmeyer, n.d.), which is another behavioral trap.

Continuing VFR into Instrument Conditions. This behavior occurs when a pilot under a VFR flight plan (or no flight plan at all) flies into adverse weather or into weather conditions where controlled flight is only possible by using the aircraft's instruments. This type of flight requires additional training the pilot may or may not possess. This behavioral trap has been one of the most studied by scholars and the FAA (Ison, 2014).

Scud Running and Continuing VFR into IMC are very similar to one another. In many cases, Scud Running leads to Continuing VFR flight into Instrument Conditions. A Scud Running pilot should get an ATC clearance but usually does not because of complicated delays it might bring about. Scud Running and Continuing VFR into Instrument Conditions degrades decision making and flying skills due to self-imposed stress and fear.

Getting Behind the Aircraft. Pilots are trained to manage flight complexity successfully. However, as much as a pilot might think otherwise, every person has a limit. This limitation is related to other factors such as workload. According to the FAA (2008), Getting Behind the Aircraft occurs when a pilot loses the ability to be proactive and allows situations and events to control pilot action. The pilot lives in a constant state of surprise regarding what happens next.

Loss of Positional and/or Situational Awareness. The FAA defines Loss of Positional and/or Situational Awareness as the maximum expression or ultimate manifestation of Getting Behind the Aircraft. During Loss of Positional/Situational Awareness, the pilot is unaware of the geographical position of the aircraft or is oblivious to the multiple factors that impact the flight (e.g., plane, passengers, environment, air traffic control).

Jeppesen (2014) has combined Getting Behind the Aircraft and Loss of Positional/Situational Awareness, and for the purposes of this research the categorization of these two behavioral traps by Jeppesen will be used. The combination will be called Loss of Situational Awareness.

Operating Without Adequate Fuel Reserves. This behavioral trap occurs less in Part 121 than in GA operations because air carrier pilots have multiple resources at their disposal; one of which is dispatch. During airline operations, dispatchers are tasked with fueling procedures while pilots monitor and assess the available fuel prior to and during the flight. However, in GA there may be only one set of eyes on the issue; consequently, there are many instances of Operating Without Adequate Fuel Reserves. In 2004, a total of 79 fuel exhaustion accidents occurred, of which four were fatal (Fuller & Steuernagle, 2006). Of all the factors that lead to aviation accidents, fuel should be one of the easiest to address.

Flying Outside the Envelope. Flying Outside the Envelope occurs when pilots exceed airplane limitations such as airspeeds, application of aircraft structure devices, bank angles, and weight limitations, to name a few. A pilot who flies outside the airplane parameters may believe rules related to the aerodynamics and performance capabilities of the aircraft, placed in manuals and/or placards have a built-in safety margin.

Neglect of Flight Planning, Preflight Inspections, and Checklists. Air carrier operations are highly *scripted* (Dismukes et al., 2007). Accident investigators frequently identify crew errors by comparing their actions to those written in the airline's instructional document called the Flight Operations Manual (FOM). The FOM contains the procedures and steps to perform during normal and abnormal flight conditions. If at any time a pilot deliberately or unconsciously bypasses a procedure, checklist, inspection or flight planning process, the action can be classified under this behavioral trap. Examples include failure to execute a published procedure, deviations from established norms, and failure to follow checklist items. A pilot may choose to circumvent the procedures listed in the FOM due to familiar or routine flight operations or by overestimating short and long term memory skills.

Behavioral Traps and Hazardous Attitudes

Behavioral traps and hazardous attitudes share many commonalities. An individual experiencing Anti-authority will probably fall under the behavioral trap of Duck-Under Syndrome or Neglect of Flight Planning, Preflight Inspections, and Checklists. An aviator exhibiting Macho could experience the behavioral trap known as Flying Outside the Envelope. Scud Running and Operating Without Adequate Fuel Reserves are indicative of the hazardous attitude known as Invulnerability. The behavioral traps known as Mind Set and Get-There-Itis are signs of a pilot affected by Impulsivity. Lastly, Getting Behind the Aircraft and Peer Pressure both characterize pilots with the hazardous attitude identified as Resignation. Table 3 illustrates the associations between hazardous attitudes and behavioral traps that have been carefully gleaned from the literature.

Table 3

Association Between Behavioral Traps and Hazardous Attitudes

Behavioral Trap	Hazardous Attitude
Peer Pressure	Resignation
Mind Set	Impulsivity
Get-There-Itis	Impulsivity
Duck-Under Syndrome	Anti-authority; Invulnerability
Scud Running	Anti-authority; Invulnerability
Continuing Visual Flight Rules (VFR) into Instrument Conditions	Anti-authority; Invulnerability
Getting Behind the Aircraft	Resignation
Loss of Positional / Situational Awareness	Resignation
Operating Without Adequate Fuel Reserves	Anti-authority; Invulnerability
Descent Below the Minimum En Route Altitude	Anti-authority; Invulnerability
Flying Outside the Envelope	Macho; Anti-authority
Neglect of Flight Planning, Preflight Inspections, and Checklists	Anti-authority; Invulnerability

Research on Risky Airmen and Selected Behavioral Traps

Much research has been conducted on pilot risk assessment and behavior. Within these research endeavors, a few select behavioral traps have been studied directly or indirectly. The following pages highlight many of these studies.

O'Hare and Wiegmann (2003) found that pilots who flew into adverse weather differed in risk perception compared to those who diverted to another airport.

Specifically, pilots who flew into adverse weather gave lower ratings of the risk of continuing into adverse weather than those pilots who diverted. However, the pilots who continued also rated the risk of continuing into adverse weather as higher than the risk of diverting. Yet, they still chose to fly into the adverse weather.

Pauley, O'Hare, and Wiggins (2008) found that risk tolerance is a good predictor of risk-taking. Flight instructors were asked to assess the level of opportunity or threat in a series of 36 scenarios presented on paper. Relationships were established between many variables such as categories of threat (e.g., environment) and categories of opportunity (e.g., income from passengers). Their study suggests that some pilots may fly into adverse weather because of a greater tolerance of risk. The study examined various behavioral traps indirectly. These were Mind Set, Get-There-Itis, Peer Pressure, and continued VFR into IMC.

Drinkwater and Molesworth (2010) examined the predictors of pilots' risk management behavior. This study sought to determine if there were known attitude and risk perception markers and/or personal characteristics, such as flight experience and age, which predicted the acquisition and utilization of risk management skills. The study presented 56 participants with a risky simulated flight which involved minimal fuel on board their aircraft and a search for a wayward parachutist. A clear distinction in terms of risk perception was evident between those pilots who elected to undertake the risky flight (36 participants) and those who did not (20 participants). This study suggests that pilots' recognition and perception of immediate high risks in aviation relate to behaviors that attempt to minimize risk to the lowest possible level. Of the pilots who undertook the trip, and thereby encountered a higher level of risk, older pilots were more willing to engage in risky behaviors. Finally, those pilots with higher levels of self-confidence were more eager to attempt to minimize the risks in a hazardous situation.

Hunter, Martinussen, Wiggins, and O'Hare (2011) surveyed over 300 GA pilots regarding previous weather events and the circumstances associated with those flights. Pilots completed a web-based questionnaire containing demographic questions, a risk perception scale, a hazardous events scale, and a pilot judgment scale. The pilots who reported a flight in which they penetrated weather without authorization or were concerned about the weather also completed 53 additional questions regarding their weather encounter. The results of their study indicated that 32% of pilots who flew into instrument conditions (VFR into IMC) did so deliberately. Marginal weather was forecast along the route of flight for 33% of the pilots who flew VFR into IMC. In addition, pilots who flew VFR into IMC had poorer judgment scores and less conservative personal minimums than those who did not report a weather encounter. Finally, pilots who flew VFR into IMC were less likely to have an instrument rating than those who did not fly into adverse weather. Indirectly, the survey examined the behavioral traps known as Scud Running, Continuing VFR into IMC, Peer Pressure, and Get-There-Itis.

Survey research can also be used to gauge a pilot's proclivity to undertake risky behaviors. Ji, You, Lan, and Yang (2011) conducted a survey of 118 pilots of Chinese Southern Airlines in an attempt to study the profile of the risky pilot. They concluded that when risk perception increases, the negative effects of risk tolerance on safe operational behavior decrease. In other words, safety increased when a pilot was capable of perceiving risk adequately.

Pilot Cognitive Biases and Antecedents to Operational Errors

A cognitive bias is a distortion in the way a person perceives reality (Cherry, 2015). There are certain pilot cognitive biases that may affect the safety of flight. Dismukes et al. (2007) analyzed 19 major U.S. accidents between 1991 and 2000 in which the NTSB identified crew error as a causal factor. Various common cognitive bias themes emerged from this study; nine accidents were the result of, or influenced by, *plan continuation bias*, a tendency to remain fixed on the pre-determined course of action or destination. Dismukes also noticed that crews succumbed to increasing workload and were unable to perform tasks well once the flight demands intensified. Finally, 4 out of the 19 accidents showed that pilots deviated from explicit guidance or SOPs. The pilot cognitive biases and operational errors found during this study resemble the behavioral traps.

Mosier et al. (2012) analyzed a total of 116 Aviation Safety Reporting System (ASRS) reports and 60 NTSB aviation accident reports to focus on human factors issues, antecedents of errors, and associated operational consequences. According to Mosier, antecedents are behavioral threats to safety and overall pilot decision making. These include (p. 1754):

1. Attention. The ability to keep track of current tasks and changing conditions.
2. Automation bias. Overreliance on automation technology leading to loss of situational awareness.

3. Expectation-driven processing. Similar to confirmation bias where a pilot seeks information that confirms rather than disconfirms their current belief of a situation.
4. Memory issues. Failures in the memory system or inability to recall.
5. Operator state. Vulnerable pilot conditions such as fatigue, stress, and distraction.
6. Team communication. Effective communication among crew members.
7. Monitoring/challenging. Maintaining vigilance during the execution of crew tasks and inquiring when deviations of correct procedures occur.

Indirectly, Mosier et al. (2012) examined a variety of behavioral traps. For example, some of the categories (variables) coded in the study were cognitive factors such as attention errors (Loss of Situational Awareness), expectation-driven processing and behavior error (Mind Set), and memory failures (Getting Behind the Aircraft). In addition, the study explored procedural errors (Neglect of Flight Planning, Preflight Inspections, and Checklists) and tactical decision errors such as plan continuation error (Get-There-Itis). The study suggests the presence of many behavioral traps in the commercial operational environment. Table 4 summarizes the associations between the pilot cognitive biases or antecedents to operational errors and the behavioral traps.

Table 4

Association Between Behavioral Traps and the Cognitive Biases or Antecedents

Behavioral Trap	Cognitive Biases or Antecedents
Peer Pressure	Team communication; monitoring/challenging
Mind Set	Expectation-driven processing
Get-There-Itis	Plan continuation bias
Duck-Under Syndrome	Procedural error
Scud Running	Tactical decision error
Continuing Visual Flight Rules (VFR) into Instrument Conditions	Tactical decision errors
Getting Behind the Aircraft	Memory failures
Loss of Positional / Situational Awareness	Attention errors
Operating Without Adequate Fuel Reserves	Procedural errors
Descent Below the Minimum En Route Altitude	Procedural errors
Flying Outside the Envelope	Procedural errors
Neglect of Flight Planning, Preflight Inspections, and Checklists	Procedural errors

The behavioral trap of VFR flight into IMC has captured the attention of many scholars and organizations and for good reason. A look into a few research facts reveals why (Ison, 2014):

- 25% of all weather-related accidents in GA are fatal.
- Of these weather-related accidents, 50% are VFR flights into IMC.
- 72% of VFR into IMC accidents are fatal.

- There is a higher incidence of VFR into IMC accidents among individuals with a private pilot certification or less as compared with people with a higher level of certification.

Ison (2014) used a regression analysis to examine the variables that better predicted a VFR into IMC accident or an unrelated VFR into IMC accident. The accident reports emanated from the NTSB's database. Factors included terrain, time of day, weather briefing delivery, flight plan filing, age of pilot, flight experience, pilot certification, and ATC communication.

Ison (2014) demonstrated that the factors of terrain and the receipt of a weather briefing statistically influenced VFR into IMC accidents. A significant number of weather briefings included the statement *VFR flight not recommended*. Unfortunately, it seems some pilots are deliberately flying into IMC. Regarding pilot certification, Ison concluded that the higher a pilot's certification, the likelihood of a VFR into IMC accident decreased. Paradoxically, a positive correlation was found between flight experience and VFR into IMC accidents. Therefore, pilots with more flight time but less education and training are at greater risk. Finally, age had a negative relationship with VFR into IMC accidents. Ison called for better education and training to GA pilots coupled with enhancements in weather briefings so that pilots are better warned and the hazards of attempted VFR flight into IMC are explained.

Wiegmann and Goh (2000) conducted an experimental study to analyze the dynamic factors influencing a pilot's decision to continue a VFR flight into adverse weather. Variables such as situation assessment, risk perception, and motivation were studied using a hypothetical (simulated) cross country flight. Differences were measured between those pilots that chose to continue flight into IMC versus those who diverted. Situation assessment referred to the ability of the pilot to recognize deteriorating weather conditions. Risk perception was the ability to correctly diagnose deteriorating weather to include the ability to recognize the risks involved with continuing the flight. Motivational factors referred to those influences that bias a pilot's decision making. These elements include the behavioral trap known as Get-There-Itis or other personal or social pressures (Wiegmann and Goh, 2000). These motivational biases may hinder flight safety even after correct situation assessment and risk perception is accomplished.

The procedure involved a pre-simulation questionnaire using the Aeronautical Risk Judgment Questionnaire (O'Hare, 1990). A total of 32 pilots answered questions regarding their demographic background, self-judgment, hazard awareness, and risk awareness. Following the pre-experimental feedback form, participants used the X-Plane Flight Simulation Program on a Pentium III 450 computer (Wiegmann and Goh, 2000). The simulation included yoke and rudder pedals and control of parameters such as ceiling, visibility, and topographical features. The departure weather was set to VFR; however, 45 minutes into the flight, the conditions were reduced to below VFR (i.e., 2 miles visibility and 1,500 feet ceiling). Once the simulation ended, pilots were required to complete another questionnaire on features such as situational awareness, self-judgment, and decisional factors.

Of the 32 pilots, 22 (68.75%) continued flight into adverse weather. Although slightly less than half of the participants were certificated pilots, that is, possessed a Private Pilot or higher certification, no statistically significant differences were found between pilots who decided to continue with the flight and those who chose to divert. A discriminant analysis demonstrated that visibility estimates (.929), skill and judgment ratings (.602) and frequency of risk-taking behavior (-.562) were most important in predicting whether or not a pilot would continue or divert from a VFR into IMC situation (Wiegmann and Goh, 2002). In combination, these three elements were able to predict whether a pilot would continue or divert with 87.1% accuracy.

According to Williams (2011), VFR flight into IMC has resulted in 87% fatalities in GA flights from 1999-2008. Lamentably, the acquisition of a weather briefing and the completion of an instrument rating does not guarantee safeguarding against VFR into IMC. In more than 50% of VFR into IMC accidents, pilots had received a weather briefing while 47% of pilots were instrument rated (Williams, 2011). Williams concludes that correct interpretation of a weather briefing coupled with a skepticism or pessimism about deteriorating weather may help pilots during the decision-making process. Williams also advocates developing and using a personal minimums checklist.

CRM and Behavioral Traps

CRM is an FAA-mandated professional training program provided by air carriers to assist captains and first officers in their use of all resources (human, hardware, and software). Effective CRM practices are predicated on following checklists, using SOPs, conducting appropriate preflight actions, and engaging in proper flight planning. Each of these practices helps prepare pilots for unexpected events during flight.

When the CRM program began, the concept was known as *Cockpit Resource Management* and was for pilots only. However, Cockpit Resource Management programs evolved to include flight attendants, maintenance personnel, dispatchers, and others and became crew resource management (Block, Sabin, & Patankar, 2007). The current definition of crew resource management includes all groups routinely working together with the flight crew who are involved in the decision making processes required for the safe operation of the flight (FAA, 2004).

CRM training is one way to address the challenge of optimizing the human/machine interface and accompanying interpersonal activities (FAA, 2009). Advisory Circular 120-51e (2004) is the official FAA document that provides guidance to air carriers on implementing CRM. According to the FAA (2004, p. 6), an effective CRM training program:

- Includes a comprehensive system of applying human factors concepts to improve crew performance.
- Embraces all operational personnel.
- Can be blended into all forms of aircrew training.
- Concentrates on crewmembers' attitudes and behaviors and their impact on safety.
- Uses the crew as the unit of training.
- Requires the active participation of all crewmembers. It provides an opportunity for individuals and crews to examine their own behavior and to make decisions on how to improve cockpit teamwork.

The major topics within a typical CRM training program are: (a) communications processes, (b) decision behaviors, (c) team building and maintenance, (d) workload management, (e) and situational awareness. Unfortunately, the FAA does not provide specific guidelines relating to attitude management as part of CRM training (FAA, 2004), nor does it provide any information about hazardous attitudes, behavioral traps, or the various cognitive biases.

Line-Oriented Flight Crew (LOFT) is a scenario-based training exercise where the crews complete the simulated flight in real time as they would during a regular trip. LOFT has been the preferred CRM tool during air carrier training for many years (Wagener & Ison, 2014). LOFT consists of simulator sessions where crews apply the CRM principles learned during class sessions. During LOFT sessions, both normal and abnormal situations are presented. Unfortunately, these LOFT sessions have been applied ineffectively and intermittently, and some sessions have not even been mandated by regulating authorities in all countries (Dismukes et al., 2007; Salas et al., 2010; Wagener & Ison, 2014).

The creation of CRM and like programs does not always guarantee the absence of unsafe pilot behaviors (Cook, 2002). Dismukes et al. (2007) cites inadequate knowledge or experience provided by training and/or guidance as a factor in 37% of NTSB accidents between 1991 and 2001. In other words, pilots were not given adequate instruction about problems known by some of the sectors of the industry to exist or, “found themselves in challenging situations for which they had received training, but the experience received from that training was of inadequate fidelity to the actual situation, inadequately detailed, or incomplete (Dismukes et al., 2007, p. 298).

TEM

During the late 1990s, TEM was introduced into CRM training. It is accepted that errors cannot be eliminated but perhaps can be avoided, managed, and their effects mitigated (Maurino & Murray, 2010). According to Helmreich, Merritt, and Wilhelm (1999), flight crews often use tactics to minimize and mitigate errors during abnormal and normal (day-to-day) activities. These strategies during CRM are called *error management.*

The current TEM model lists errors under four areas (Maurino & Murray, 2010, p. 10-14). These errors are:

1. Intentional noncompliance [error]. These are intentional deviations from regulations and/or operators' procedures.
2. Procedural [error]. This is where the intention is correct, but the execution is flawed. They also include errors where the crew simply forgot to do something that was intended—the so-called slips and lapses.
3. Communication error. This includes missing, misinterpreting, or failing to communicate pertinent information. It can be between crewmembers or between the crew and external agencies (e.g., ATC, maintenance personnel).
4. Operational decision error. These are decision-making errors in areas which are not standardized by regulations or operator procedures, and they compromise safety. To be categorized as a decision error in the TEM framework, at least one of three conditions must exist: first, the crew must have had other more conservative options available and decided not to take them. The second condition is that the decision was not discussed between the crew members. Third is that the crew had time available but did not use it to evaluate the decision.

Each of the afore-mentioned TEM errors share connections with the behavioral traps. Table 5 explains the associations between the behavioral traps and the list of errors under the TEM model.

Table 5

Association Between Behavioral Traps and TEM Errors

Behavioral Trap	TEM Error
Peer Pressure	Operational decision error
Mind Set	Operational decision error
Get-There-Itis	Operational decision error
Duck-Under Syndrome	Intentional noncompliance
Scud Running	Intentional noncompliance
Continuing Visual Flight Rules (VFR) into Instrument Conditions	Intentional noncompliance
Getting Behind the Aircraft	Procedural error
Loss of Positional / Situational Awareness	Procedural error
Operating Without Adequate Fuel Reserves	Intentional noncompliance
Descent Below the Minimum En Route Altitude (MEA)	Intentional noncompliance
Flying Outside the Envelope	Intentional noncompliance
Neglect of Flight Planning, Preflight Inspections, and Checklists	Intentional noncompliance

At times, unsafe pilot actions leading to accidents are not mistakes, but rather violations or intentional noncompliance from checklists or SOPs. English and Branaghan (2012) proposed a new violation taxonomy with four categories:

- Improvement. The intention is to increase safety or production, a desire to do better.
- Malevolent. The intention is to cause harm or reduce production, a desire to do damage.
- Indolent. The intention is to increase operator ease, a desire for lethargy.
- Hedonic. The intention is to increase operator excitement, a desire for sensation.

Using this new taxonomy, the first author reviewed NTSB accident reports with substantial narrative information from 1980 to 2008 that included at least one of the following terms *violation*, *disregard*, *suicide*, *non-standard*, *intentional*, or *non-compliance*. The authors looked to compile accounts together if they could be considered somewhat similar, splitting only those that appeared profoundly different. The authors tested the reliability of the new taxonomy by having aviation safety experts review accident reports and classify the violation behavior. The authors hoped that other researchers, using this new taxonomy as a tool to continue to understand the motivational factors surrounding unsafe pilot behavior, could complete additional studies.

Participants were pilots familiar with use of the Human Factors Analysis Classification System or similar schemes. They had varied civilian and military backgrounds and were either faculty at the U.S. Air Force Academy, safety analysts at a U.S. major airline, or U.S. major airline pilots working as Line-Oriented Safety Audit observers. The average self-reported professional flying experience in the returned surveys was 11,330 flight hours obtained during 21.2 years working within the aviation community. All participants were over 21 years old and received no payment for participation (English & Branaghan, 2012, p. 206).

Helmreich, Klinect, and Wilhelm (2001) stated that the highest percentage of errors (50%) involved deliberate non-compliance. Klinect et al. (2001) found that examples of willful violations occurred in 35% of regular air carrier flights observed. Finally, Velazquez et al. (2015) found that the behavioral trap known as Neglect of Flight Planning, Preflight Inspection, and Checklists was found in 72% of accidents attributed to flight crews in Part 135, Part 121, and other foreign accidents analyzed between 1988 and 2006.

Although the above-mentioned evidence suggests that some pilots have a general disregard for rules, Maurino and Murray (2010) state that often *optimization* "is the most frequent cause of intentional noncompliance and is perceived by the crews as being necessary, because the rules and the tasks are often incompatible and sometimes mutually exclusive" (p. 10-14). Optimization is defined by Merriam-Webster's (2015) online dictionary as the act, process, or methodology of making something (such as a decision) as fully perfect, functional, or effective as possible. Many researchers prefer the word *adaptability* (FAA, 2004; Fornette, Bourgy, Jollans, Roumes, & Darses, 2014). Adaptability is defined as "an individual's ability, skill, disposition, willingness, and/or motivation, to change or fit different task, social, and environmental features" (Ployhart & Bliese, 2006, p. 13). Regardless of the term used, crewmembers apply different strategies to enhance management of complex and unforeseen situations during flight.

During TEM, aircrews apply risk management strategies to avoid, trap, and mitigate errors (Velazquez & Bier, 2015). However, for pilots, recognizing self-attitudes or personality threats that are hazardous to flight safety is not easy, although it is a necessary task during CRM. Furthermore, the act of one crewmember challenging another crewmember during the recognition of someone else's negative behavior could prove quite troublesome. Salas and Cannon-Bowers (2001) call this challenging action *task-related assertiveness*, which is the "willingness/readiness of team members to communicate their ideas, opinions, and observations in a way that is persuasive to other team members and to maintain a position until convinced by the facts that the other options are better" (Salas, Wilson, Burke, Wightman, and Howse, 2006, p. 8).

Wagener and Ison (2014) call for strategic cockpit procedures and guidelines on how to deal with socially sensitive issues such as challenging flight crew members during multi-crew operations. They suggest that additional research be conducted to identify breakdowns in CRM. Wagener and Ison also proposed a qualitative study of airline CRM training to assess themes and alignments of goals, policies, training, and evaluation with topics such as TEM, human behavior, use of automation, and team dynamics. They also suggest a study of CRM monitoring and challenging with assertiveness.

According to Broome (2011), execution of good CRM practices is obstructed by internal barriers such as: frustration, anxiety, hazardous attitudes, anger, and Get-There-Itis, among other elements. In addition, Broome believes that even though CRM has had wide acceptance, there are still pilots who reject the concept. It is imperative upon senior management that these individuals are not put in a situation where their attitudes/

personalities jeopardize the safety of others and are not influential on junior crewmembers (Helmreich & Butler, 1991).

External factors such as airline management may exacerbate behavioral traps. Air carrier personnel may negatively affect the decision making capabilities of a crew. Fanjoy, Harriman, and DeMik (2010) conducted a study to know the individual and environmental predictors of pilot burnout within Part 121 regional airlines. It seems that subtle organizational pressures associated with continued employment frequently overrule common sense decision making that has been the symbol of industry pilots (Fanjoy et al., 2010). On-time performance, acceptance of airplanes with less fuel, or inoperative components is adding stress and fatigue to airline pilots. A term called *pilot pushing* exemplifies such pressures. Pilot pushing is “the pressure that pilots face from management to keep airplanes in the air as much as possible by agreeing to fly legs with critical equipment problems, in severe weather, with reduced fuel requirements, or in a state of fatigue” (Fanjoy et al., 2010, p. 19). Symptoms of burnout may include irritability, depression, absenteeism, anxiety, diminished attention, and attrition.

To investigate further, the authors administered a survey regarding pilot burnout to 248 regional pilots. The survey was an aviation-adapted version of the Maslach Burnout Inventory-General Studies (MBI-GS). The instrument consisted of 22 questions designed to measure three aspects of burnout (i.e., exhaustion, cynicism, and professional efficacy). Likert-type response scales indicated how often the pilots experienced a given thought or feeling.

The last section of the questionnaire measured the pilots’ perception of pressure from airline management to complete a flight with questionable safety risks or hazards.

This included: accepting aircraft with critical equipment problems, starting or continuing flight into severe weather or icing conditions, accepting critically reduced fuel requirements to accommodate revenue, and overall pressure to make on-time goals. Constructed in a format similar to the MBI-GS items, answers to these items indicated how often the respondents experienced this type of pressure, ranging from 0 (never) to 6 (daily) (Fanjoy, Harriman, & DeMik, 2010, p. 21).

Results from the Fanjoy et al, 2010 study established, among other facts, that:

- 32.6% of the sample population was identified as high burnout candidates,
- 51.8% of the sample was identified as exhibiting high exhaustion levels,
- 2.5% exhibited high cynicism levels, and
- 53.8 % of the sample displayed low professional efficacy levels.

The study further highlights the presence of behavioral traps such as Peer Pressure and Get-There-Itis.

Attitudinal and Team Factors Affecting Error Detection During CRM

Kontogiannis and Malakis (2009) identified several attitudinal influences that affect a person's ability to identify errors during flight. Attitudinal factors refer to "the orientation the person has to the situation, the feelings and stance towards other colleagues and the level of arousal or anxiety" (p. 701). These attitudinal factors may occur during single-pilot operations as well as multi-crew operations. Kontogiannis and Malakis have summarized a total of four attitudinal factors:

1. Vigilance and Alertness. A pilot may attempt to comprehend an unfamiliar situation by drawing inaccurate analogies to past experiences. Mistakes in

vigilance and alertness also refer to complacency or a sense of self-satisfaction accompanied by unawareness of actual dangers or equipment deficiencies. This danger is prevented by proper planning, suspicion, and curiosity before and during a flight.

2. Awareness of Vulnerability. Very much akin to the previous factor, a pilot decreases his/her awareness of vulnerability during moments of false optimism. A pilot may be overconfident and tolerant of conflicting evidence due to recurrent success. A healthy level of skepticism increases awareness to vulnerability.
3. Degradation and disengagement. It is crucial for a pilot to monitor his/her own performance and mental state. The symptoms of degradation and disengagement include staying behind the situation, suffering a constant distraction, feeling surprised even by small events, and feeling fatigued. Pilots commonly refer to this factor as being *out of the loop.*
4. Frustration from errors. As errors build up, further detection of new errors and later attribution of blame may cause stress and frustration. Nurtured by harsh self-criticism or fear of blame, pilots may attempt to cover the problems instead of recovering from them. This attitudinal factor may encourage *groupthink* which is a tendency to suppress one's own arguments if these are not consistent with that of the team.

The attitudinal factors previously mentioned share analogies with some of the FAA-defined behavioral traps. An overconfident pilot suffering from a lack of vulnerability awareness may engage in Neglect of Flight Planning, Preflight Inspections, and Checklists; Duck-Under Syndrome; Operating Without Adequate Fuel Reserves; or even Flying Outside the Envelope. Degradation and disengagement is analogous to the behavioral trap known as Getting Behind the Aircraft. Finally, an argument can be made that the behavioral trap called Peer Pressure may lead to the attitudinal factor known as frustration from errors.

Kontogiannis and Malakis (2009) also present a series of team factors that affect the ability to identify errors during crew operated flights. These team factors affecting error detection are:

1. Assertiveness. The ability to voice concerns during crew operated flights can prove quite difficult, as indicated earlier. Even so, assertiveness during normal and abnormal flight events remains an important component of CRM.
2. Cross-checking others and monitoring for signs of fatigue. The ability to notice signals of a crewmember's disengagement and degradation is paramount for the safety of flight.
3. The ability to adopt multiple perspectives. Because crews are often trained in couples, pilots can frequently determine if the action of their colleague is aligned with the goals for the flight. This action requires a broader perspective by the observing pilot. The more tasks are shared among team members the better a team is prepared to detect errors.
4. Communication of intent. Where the previous factors may fail, communication remains a key pillar to the effective CRM. Communication remains the most direct approach to figuring out the intentions of the other

crew member. Adequate communication may even prevent errors from occurring in the first place.

First Officer Experience

The NTSB studied several first officer factors that led to many accidents between 1978 and 1990. A total of 32 accidents were available. One of the most intriguing findings was that 53% of first officers had less than a year of experience in that capacity/position at the airline (Dismukes et al., 2007). This percentage decreased slightly in accidents between 1991 and 2001, that is, 41% of first officers had less than a year of experience in position. 84% of accidents between 1978 and 1990 had incidences of monitoring and challenging of errors, while this number decreased in accidents between 1991 and 2001 (68%).

It is conceivable that low time as a first officer at an airline could increase the risk of accident appreciably. Although airline first officers are trained to high standards and typically have considerable experience, during the first years, first officers are to some extent still honing their skills at flying the particular airplane, monitoring, and detecting errors. During the first year, “first officers are typically on probation (unless they have previously held flight engineer positions at the same airline) and conceivably may be less willing to challenge the captain’s decisions and actions” (Dismukes et al., 2007, p. 282).

Additional Individual Factors Associated with Behavioral Traps

Van Benthem and Herdman (2014) conducted an extensive literature review on the factors that led to Loss of Situational Awareness events in GA and found that the interaction of factors such as age, certification level, and total flight hours with pilot performance continues to puzzle many researchers. Li, Baker, Qiang, Grabowski, & McCarthy (2005) explored various risk factors associated with aviation accidents and found that pilots over 65 years of age were more likely to be involved in an accident as opposed to younger pilots between the ages of 25 to 34 years. Bazargan and Guzhva (2011) found that pilots over 65 years of age were also more likely to be involved in fatal accidents than their younger equals. Unexpectedly, pilots with fewer flight hours were least likely to be involved in fatal accidents (Bazargan and Guzhva). Taylor, Kennedy, Noda, and Yesavage (2007) reported lower performance for older pilots when "following ATC messages, traffic avoidance, cockpit instrument scanning, and approach and landing ability" (p. 201). This last study also found that pilot certification level is the most reliable indicator of pilot expertise and performance. Finally, Coffrey, Herdman, Brown, and Wade (2007) found that older pilots missed a larger amount of critical events or abnormal events both inside and outside the cockpit than their younger counterparts.

Rebok, Qiang, Baker, McCarthy, and Li (2005) studied the relationship between flight experience and pilot violations in commuter and air taxi pilots. Their data were collected from the biannual medical certification data and surveillance systems managed by the NTSB as well as the FAA's Aviation Medical Examiner System and Medical Accident System. Results showed that flight experience was negatively associated with violations. Pilots with less than 5,000 hours of flight time were at a higher risk than pilots with flight time between 5,000 and 9,999 hours. However, this *protective* effect of flight experience lessened as pilots had more than 10,000 hours of flight time.

Moral Development and Pilots

Perhaps aviation is lacking ethical education and overall awareness of ethical issues inherent to the industry. Today, more and more professional industries are increasing ethics education and have a published set of ethical standards. Morality was defined as a set of human laws that pursue harmony among persons and groups whereas ethics embraces the study of morality and established practical standards to define morality more precisely (Diels, Northam, & Peacock, 2009). According to Diels et al. (2009), continued lectures on ADM and CRM should be supplemented by education in ethics, particularly because pilots are faced with dilemmas and tradeoffs such as effectiveness, efficiency, safety, and satisfaction. Although aviation is largely regulated and imbued with standard operating procedures, there are always gray areas that require judgment and ethical decision making.

Using one of the most common measures of moral development, the Defining Issues Test 2 (DIT2) Diel et al. conducted a study of three groups of pilots (e.g., students, flight instructors, and faculty members at ERAU) to examine moral development levels in terms of P score on the DIT2. All completed assessment response sheets were returned to the University of Minnesota Center for the Study of Ethical Development, for scoring. Comparisons were then conducted between the three groups. No significant relationships were found between age and moral development nor education and moral development. However, the flight instructors and student pilots scored lower than expected in the DIT2 questions. Concern was elevated because flight students scored lower than regular high school students, and flight instructors scored lower than average college students. The authors posited that this may be due to a lack of ethics training in aviation programs.

A Study Targeting Commercial Operations and Hazardous Behaviors

Cook (2002) conducted a study on hazardous behaviors and causal factors (HB/CF) found in Part 121 and 135 accidents and incidents. The NTSB has a list of common HB/CF for accident investigative purposes. The HB/CF were those defined by the NTSB, and the author was instructed to select these codes. The NTSB behavioral categories included in Cook's study were:

- Inadequate preflight inspection
- Decision height disregard
- Organizational pressure
- Anxiety
- Over confident
- Inflight planning not followed
- Other procedures not followed
- Other pressure
- Depression
- Other psychological factor
- VFR into IMC
- Number of other procedures not followed
- Alcohol
- Stress
- Flight into known adverse weather
- False information

- Illegal drugs
- Complacency
- Flight with known aircraft deficiencies
- Self-induced pressure
- Medication
- Ostentatious display

The Cook (2002) study consisted of a literature review and statistical analyses on Part 121 and Part 135 accidents from 1983 to the year 2000. The analyses conducted as part of the study of accidents included frequency distributions, regression, and correlations to identify HB/CF frequency distributions and relationships between behavioral and demographic data. VFR into IMC, one of the FAA-defined traps, was the leading behavior found in 28.7% of the accidents analyzed. The average pilot age was 38 years old with an average of 5,752 Pilot in Command (PIC) hours accumulated. A regression model predicted that as age increased total HB/CF decreased. Finally, IMC was found in 56.7% of accidents (Cook, 2002).

A few behavioral traps were studied during the Cook (2002) study. These were: VFR into IMC, other procedures not followed, inadequate preflight inspection, and decision height. Though the literature reviewed and the statistical analyses help confirm the existence of unsafe pilot attitudes at the commercial level, the study suffers from various drawbacks. CRM has traditionally been a Part 121 assignment and not always the case for Part 135 operators until recently. This fact can yield different results when analyzing the hazardous behaviors from Part 135 operators versus those found in Part 121 pilots. Unexpectedly, as admitted by Cook, VFR into IMC was the leading hazardous behavior across all accidents analyzed. This finding should not occur if accidents from Part 121 are analyzed separately from those accidents in Part 135 because Part 121 operations are strictly conducted under IFR. Furthermore, the author combines accidents from fixed wings airplanes with rotary wings or helicopter operations.

Perhaps the major drawback from the Cook (2002) study was the identification of the hazardous behaviors by only the author himself. Although Cook requested specific information from the NTSB to ensure that accidents encompassed such behaviors, it is the author himself who is the only person categorizing the behaviors and conducting the literature review of the accident reports. The current study used a team of SMEs to reduce bias and increase reliability during the identification of the FAA-defined behavioral traps.

Cook (2002) found many disconnects between the captain and the rest of the crewmembers, particularly the flight crewmembers. Problematic issues included the captain ignoring the crew, complacency, overconfidence, and creating a hostile cockpit atmosphere. Because the study combines accidents from rotary and fixed-wing and Part 121 with Part 135 operations, these findings need to be segregated to see if the problematic areas are common to all commercial sectors and operations.

Summary

Although it is regularly quite difficult to determine with certainty why accident crewmembers perform the way they did, it is possible to understand the types of errors and behaviors to which pilots are vulnerable and to identify the cognitive, task, and organizational factors that profile that vulnerability (Dismukes et al., 2007). Hazardous attitudes and behavioral traps increase the likelihood of an aviation accident due to pilot error. Studies have suggested the presence of many unsafe pilot attitudes during airplane accidents and the existence of cognitive biases that impair judgment. Unfortunately, many studies have been limited to the single-pilot GA domain.

The proposed study will investigate behavioral traps in multi-crew Part 121 environments. Many inconsistencies remain as to how age and flight experience relate to unsafe pilot attitudes. For example, Wetmore and Lu (2006) discovered that increases in hazardous attitudes relate to greater risk-taking, poorer aeronautical decisions, increased pilot error, and decreased utilization of cockpit resources. Wetmore & Lu (2005a) found that pilot age does not correlate to hazardous attitudes. Finally, advanced pilot certificates and flight experience each correlate to a reduction in hazardous attitudes (Wetmore & Lu, 2005b). However, according to Drinkwater and Molesworth (2010), older pilots are more willing to engage in risky behaviors, and those with higher levels of self-confidence attempt to minimize the risks in a hazardous situation. Li et al. (2005) and Bazargan and Guzhva (2011) have established that older pilots are also more likely to be involved in accidents (fatal and non-fatal). Yet, according to Pauley et al. (2008), age and flight experience do not affect a pilot’s decision to penetrate adverse weather. One of the objectives of this study was to settle many of these inconsistent findings but in the multi-crew environment.

The FAA lacks guidance in attitude management training within CRM (Velazquez et al., 2015). Unsafe pilot actions, including noncompliance and willful violations, are present in many air carrier operations. Error management in CRM can assist in identifying and mitigating threats only when pilots are cognizant of attitudes that pose a threat to flight safety, either their own or those present in fellow crewmembers, and take the necessary actions to prevent these.

To increase overall aviation safety, researchers must continue to understand what kind of errors still exist and what makes pilots vulnerable to these unsafe behaviors including the interplay of factors contributing to these conducts. These factors consist of weather, which was cited in 33.9% of aviation accidents between 1978 and 2001 (Dismukes et al., 2007), age, flight conditions, and time of day, among others. As previously mentioned, although no direct study has been accomplished on behavioral traps within the air carrier environment, some of the hazardous attitudes, cognitive biases, and errors relate to the behavioral traps themselves. Table 6 summarizes these relationships.

Table 6

Summary of the Associations Between Behavioral Traps and Other Pilot Behaviors

Behavioral Trap	Hazardous Attitude	Cognitive Biases	TEM Errors
Peer Pressure	Resignation	Communication; monitoring /challenging	Operational decision error
Mind Set	Impulsivity	Expectation-driven processing	Operational decision error
Get-There-Itis	Impulsivity	Plan continuation bias	Operational decision error
Duck-Under Syndrome	Anti-authority; Invulnerability	Procedural error	Intentional noncompliance
Scud Running	Anti-authority; Invulnerability	Tactical decision error	Intentional noncompliance
Continuing VFR into IMC	Anti-authority; Invulnerability	Tactical decision error	Intentional noncompliance
Getting Behind the Aircraft	Resignation	Memory failures	Procedural error
Loss of Situational Awareness	Resignation	Attention errors	Procedural error
Operating Without Adequate Fuel Reserves	Anti-authority; Invulnerability	Procedural errors	Intentional noncompliance
Descent Below the Minimum En Route Altitude	Anti-authority; Invulnerability	Procedural errors	Intentional noncompliance
Flying Outside the Envelope	Macho; Anti-authority	Procedural errors	Intentional noncompliance
Neglect of Flight Planning, Preflight Inspections, and Checklists	Anti-authority; Invulnerability	Procedural errors	Intentional noncompliance

CHAPTER III

METHODOLOGY

An analysis of archival data was used to determine if behavioral traps exist in the multi-crew environment. The initial portion of this study was accomplished using a qualitative approach including SMEs to explore the behavioral traps of 14 CFR Part 121 accidents. The archives were the NTSB AARs. The latter portion of this study used a quantitative approach to examine the relationships between the behavioral traps and the selected variables such as age, flight experience, weather, flight conditions, certification level, and time of day.

Research Approach

This study utilized archival research methods to explore the behavioral traps contributing to flight crew accidents. This research drew from the population of 34 NTSB U.S. aviation accidents attributed to flight crew error from 1991 to 2013. Accident reports were used to explore exclusively commercial Part 121 flight crew-related accidents. In addition, once the behavioral traps were described and understood, several correlations were conducted to explore the relationships between the behavioral traps and the factors surrounding the aviation accidents, such as the captain's age, the captain's flight experience, the first officer's age, the first officer's flight experience, the first officer's certification level, weather, flight conditions, and the time of day.

Population

The primary data source was the NTSB AARs and NTSB factual reports. The AARs and factual reports contained the information needed to explore the underlying human error issues surrounding the unsafe pilot behaviors, that is, the behavioral traps contributing to the aviation accidents. Purposive, also known as judgmental, sampling was used to study only those NTSB accident reports where flight crew error was a causal factor.

There are various reasons for selecting the time frame specified. First, beyond 1991, the NTSB has consistently generated factual reports in its analysis of aviation accidents. Second, the years 1991 to 2013 were selected because the vast majority of the factual reports had already been upgraded from preliminary to final status. The accident reports were downloaded from ERAU's website collection of NTSB AARs. Then, these reports were analyzed for evidence of behavioral traps. Third, beginning in 1991, CRM training had been established successfully at most U.S. airlines and was maturing (Helmreich et al., 1999). An analysis of behavioral traps during this period, albeit to a very limited degree, (indirectly) highlighted successes or shortcomings with such a training program.

Sources of the Data

The data collected from the NTSB had to conform to the following criteria: U.S. 14 CFR Part 121 airline accidents that were partly or wholly attributed to flight crew error. In addition, the accident must have involved death, serious injury, or substantial damage to the aircraft.

Excluded from consideration were accidents that were classified as having undetermined causes and those that were attributed to sabotage, suicide, or criminal activity such as hijacking. Accidents attributed to maintenance issues are only included if improper crew decisions contributed to the accident.

Data Collection

A team composed of four certified flight instructors (CFIs) served as SMEs and coded the data. These SMEs had either a commercial or an airline transport pilot (ATP) certificate. The possession of a flight instructor certificate and either a commercial or ATP certificate ensured that all SMEs have (1) been exposed to commercial operations and (2) taught the concepts of hazardous attitudes and behavioral traps to students. All SMEs became thoroughly familiar with the behavioral traps by receiving the necessary instruction on these unsafe pilot behaviors before the data were coded and analyzed. Familiarization training and evaluation sessions included case studies with examples of behavioral traps categorization techniques (please see Appendix C – Ground Lesson/Familiarization Training on Behavioral Traps). The use of three examples assisted the SMEs when identifying the behavioral traps and the underlying human error issues surrounding them. The SMEs used a subset of the FAA-defined list of behavioral traps to classify the unsafe pilot behaviors. After training, the aircraft accidents were randomly assigned to the SMEs such that at least two different SMEs independently analyzed each accident.

Using the narrative data obtained from the NTSB as the first step into the analysis, the SMEs used the AARs and Factual Reports to assemble a chain of events for each accident. It was necessary for both SMEs to agree on what constituted an event, the sequence of events, the pilot actions associated with those events, and how the events affected decision making and CRM. Next, the SMEs examined the reports for evidence of pilot actions related to behavioral traps. Again, both SMEs had to agree on what constituted a pilot action and if that action was reflective of a behavioral trap. Any incongruities among the SMEs were dealt with through integrative sessions. These sessions allowed ideas and notes to be cross-compared with the other SME that shared the same NTSB report. This final act led to new observations and/or linkages which resulted in revisions in the data collection process.

During the identification and classification of the unsafe pilot behaviors, the SMEs used a list of descriptors (see Appendix C – Ground Lesson or SME Familiarization Training). Some behavioral traps, as defined by the FAA, presented challenges to the coding team. Jeppesen (2014) categorized the behavioral traps as instrument operating, commercial operating, or single-pilot/general aviation operational pitfalls. For the purposes of studying the behavioral traps in the airline environment, only the instrument and commercial traps were considered because all Part 121 operations are conducted on IFR flight plans. In addition, Loss of Situational Awareness and Getting Behind the Aircraft were combined into one behavioral trap. The analysis of behavioral traps in this study used the Jeppesen process. Lastly, there are two behavioral traps that apply to aircraft being operated on instruments: Duck-Under Syndrome and Descending Below the MEA. For the purposes of this study, these two behavioral traps were combined into a new classification termed *Unauthorized Descent Below an IFR Altitude.*

The goal of this research project was to discover what behavioral traps may exist in the Part 121 accident world. Although the behavioral traps were used as *a priori codes,* the coding process of the SMEs included the thorough review of each NTSB report for key text identifying operational errors that led to the behavioral traps themselves. The NTSB reports were independently coded and subsequently cross-checked to develop consistency in coding (inter-rater consensus).

A tally sheet (see appendix B) was used to gather the necessary information from the SMEs. This information includes the coding of behavioral traps and other surrounding factors or variables of the aviation accident such as crew age, weather, and flight conditions. The coded text passages within the NTSB document, although done manually by the pilot experts, was subsequently entered into a qualitative data analysis software called QSR NVivo.

Treatment of the Data

The treatment of the data included descriptive statistics demonstrating the prevalence of each behavioral trap across the aviation accidents and the most prominent contributing factors, as well. However, with NVivo, the data transitioned beyond descriptions of the coded text to an analysis of associations, comparisons, and pattern identifications. Comparing and contrasting the data may reveal systems, relationships, and processes that could not be discovered in the manual coding stage. This type of analysis within NVivo is called relational analysis. When investigating relational patterns, the researchers explore specific connections between pairs of codes in the data, some by building a data narrative, and others by examining relationships between categories within the data (Bazeley, 2013).

Relationships between the variables were examined through several correlations, one of which was a point-biserial correlation calculated within SPSS. According to Field (2009), a point-biserial correlation coefficient r_{pb} examines the relationship between a continuous variable that is a discrete dichotomy (e.g., yes or no, dead or alive). The other statistical test performed was a Phi correlation. A Phi correlation is used when both variables are categorical and each variable has only two categories (2009). Correlation matrices will demonstrate the relationships between the variables under study.

Reliability and Validity of the Data

To assess the quality of the qualitative portion of a study, researchers may employ four tests named: credibility, dependability, transferability, and compatibility (Lincoln & Guba, 1985). Some of these tests were more applicable to this archival design than others.

Credibility refers to accuracy; the descriptions of the events or aviation accidents and antecedents must be plausible and recognizable. Credibility was achieved by including other investigators in the study, namely the SMEs.

Dependability is more suited to interviews or observational research and refers to the extent to which another researcher, with similar training and rapport with participants, makes the same observations. Although not entirely applicable to archival studies, the SMEs still cross-checked their coding process against each other and, in similar fashion, gained dependability.

Transferability refers to the generalizability of the study findings to other settings, populations, and context. This test of quality is usually one weakness of studies involving qualitative methods; however, sufficient details regarding methodology procedures allow readers to assess this. Transferability is akin to external validity. The interpretations and conclusions of this study could be applicable to most U.S. air carrier environments resulting in good external validity (Creswell, 2005).

Finally, confirmability refers to the objectivity of the data, or how much another researcher agrees with the meaning of the data. This was achieved by three methods: (1) a team – all SMEs – coded and categorized the narratives of the NTSB reports, (2) the SMEs had a coding scheme from which to work, and (3) the SMEs reconciled any differences found during the coding process by comparing their work against each other.

The behavioral traps are well defined and well-known FAA terms. The NTSB accident reports offered an accessible account that included facts, findings of causal factors, and recommendations. The focus of this research was on the human (pilot) experience as recorded by the NTSB accounts; the archives provided deep insights that were not possible with quantitative methods. The SMEs all had similar backgrounds (see Appendix D) as professional pilots and flight instructors and were exposed, through flight experience and professional training, to the concepts of unsafe behaviors by pilots.

CHAPTER IV

RESULTS

The purpose of this study was to examine the pilot behavioral traps in the multi-crew Part 121 air carrier environment. That is, what was the nature of their occurrence and with what regularity they happened in the airline domain. Another key component of this study was to explore the relationships between the behavioral traps and other factors such as age, flight experience, weather, flight conditions, time of day, and the first officer certification level.

Four SMEs analyzed 34 NTSB accident reports. These accidents conformed to the purpose of analyzing reports where flight crew error was a causal or contributing factor between 1991and 2013. During the qualitative analysis, various themes began to emerge which played significant roles in many accidents. These topics were airline management, CRM issues, fatigue, and a former behavioral trap called Flying Outside the Envelope. A discussion of these developing themes is also included in this section. The qualitative component of the SMEs' reports was uploaded into NVivo while the numerical data were analyzed with SPSS.

Descriptive Statistics

As described in the previous section, for each case, the assigned SMEs determined which behavioral traps were present. Every SME found a minimum of one behavioral trap and a maximum of four throughout the analysis. The average number of behavioral traps was two (M = 2.0) with a standard deviation of 0.60 (*SD* = .6). In addition, during the coding process the researcher asked the SMEs to identify actions representative of the behavioral traps and any contributing factors that may have influenced the outcome of the flight. Figure 1 shows the frequency with which the behavioral traps were present in all the aviation accidents. Figure 2 displays the most prevalent traps in fatal accidents.

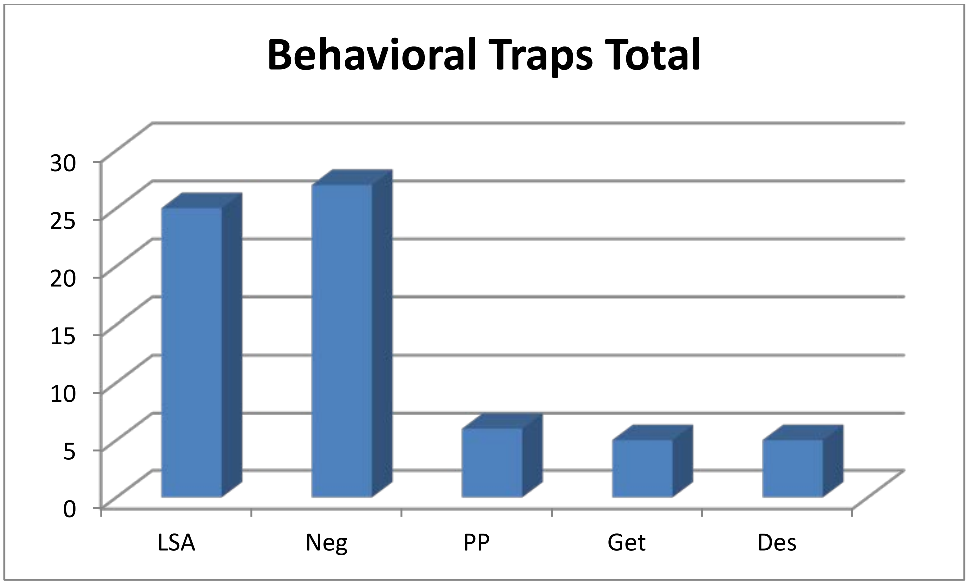

Figure 1. Frequency count of all behavioral traps found.

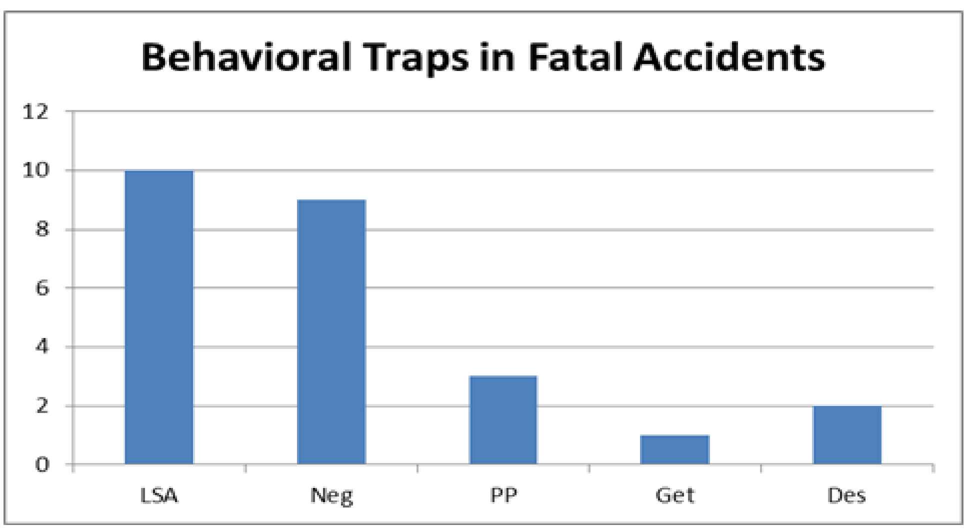

Figure 2. Behavioral traps in fatal accidents only.

The behavioral traps of Loss of Situational Awareness and Neglect of Flight Planning, Preflight Inspections, and Checklists were overwhelmingly dominant, even throughout the fatal accidents. Peer Pressure, Get-There-Itis, and Descent Below an IFR Altitude were each found in six accident reports or fewer.

Aviation accidents are generally the result of a series of simultaneous or consecutive circumstances that each add operational risk; seldom is a single isolated cause identified. During the analysis of the coding process performed by the SMEs, various themes began to emerge which played significant roles in many accidents. These topics were airline management, CRM issues, fatigue, and a former behavioral trap called Flying Outside the Envelope. This latter trap was left out of the current study due to Jeppesen's (2014) categorization of the behavioral traps among commercial, instrument-rated, and general aviation pilots. However, during training, the SMEs were alerted to the existence of all behavioral traps and were told to flag them if they saw their presence among Part 121 pilots. Figure 3 shows the distribution of these contributory factors.

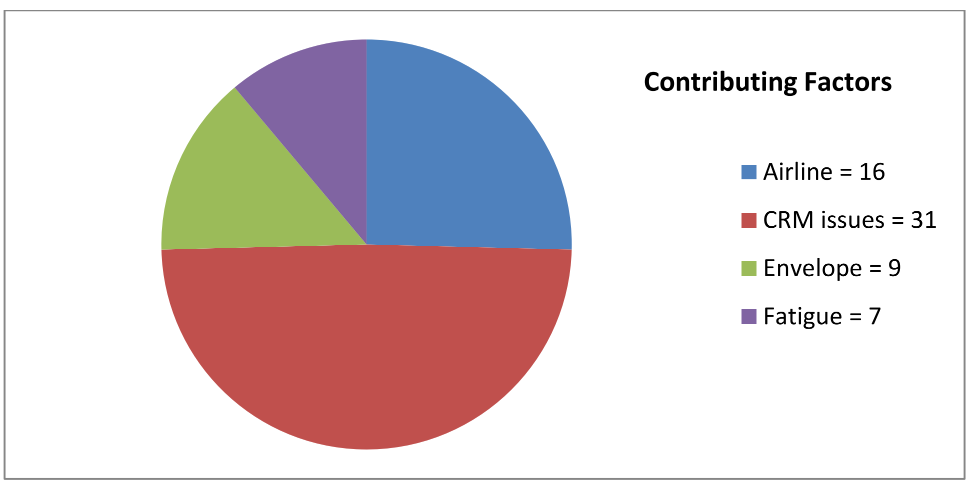

Figure 3. Other contributing factors in connection with the Part 121 accidents.

As indicated earlier, the purpose of the study was to look for associations between the behavioral traps and many other factors such as age, flight experience, weather, flight conditions, time of day, and the first officer (FO) certification level. Of the 34 accidents, 14 occurred during the day and 20 at night; also 16 were under VMC conditions, and 18 were IMC. In ten of the accidents, the FO had the Commercial Certificate, and 24 had the ATP. In 22 of the accidents, weather was a factor. This value includes those accidents occurring within IMC. Table 7 provides descriptive information about FO's and captains' ages. Much of this numerical data were found in the NTSB's factual reports of the accidents.

Table 7

Numerical Data on Captains and First Officers (FOs)

Variable	Minimum	Maximum	Mean	Standard Deviation
Captain Age	27	59	48.06	8.60
Captain Experience	2,500	23,000	11,812.97	5976.72
FO Age	24	56	38.06	7.91
FO Experience	1,800	17,744	6617.24	4571.62

Reliability Testing

So that the SMEs could record information more beneficial to the study, Table 4 a data collection instrument was not employed. Instead, a tally sheet (see Appendix B) allowed the SMEs to record their thoughts and data. To assess the quality of the qualitative portion of a study, four tests were used: credibility, dependability, transferability, and compatibility (Lincoln & Guba, 1985). Some of these tests were more applicable to this archival research design than others.

Credibility refers to accuracy; the descriptions of the events or aviation accidents and antecedents must be plausible and recognizable. Credibility was achieved by including other investigators in the study, namely the SMEs instead of having the main researcher describe the events.

Dependability is more suited to interviews or observational research and refers to the extent to which another researcher, with similar training and rapport with participants, makes the same observations. Although not entirely applicable to the current archival study, the SMEs were able to cross-check their coding process against each other and, in similar fashion, gain dependability.

Transferability refers to the generalizability of the study findings to other settings, populations, and context. This test of quality is usually one weakness of studies involving qualitative methods; however, sufficient detail regarding methodology procedures will allow readers to assess this. Transferability is akin to external validity. The interpretations and conclusions of this study could be applicable to most U.S. air carrier environments resulting in good external validity (Creswell, 2005).

Finally, confirmability refers to the objectivity of the data, how much another researcher agrees with the meaning of the data. This was achieved by three methods: (1) a team – all SMEs –coded and categorized the narratives of the NTSB reports, (2) the SMEs used a coding scheme learned during their training (see Appendix C), and (3) through integrative sessions, the SMEs reconciled any differences found during the coding process by comparing their work against each other. The behavioral traps are well defined and well-known FAA terms. The NTSB accidents reports offered an accessible account that included facts, findings of causal factors, and recommendations. The SMEs all had similar backgrounds (see Appendix D) as professional pilots and flight instructors and had been exposed, through flight experience and/or professional training, to the concepts of unsafe behaviors by pilots.

Hypothesis Testing

The study examined the relationships between the pilot behavioral traps and factors such as age, flight experience, weather, flight conditions, time of day, and first officer certification level. Because of the low sample size, N = 34, and consequently low statistical power, any significance below the .10 (*p* value level) will be highlighted. The research hypotheses, listed below, stated that there was a relationship among the behavioral traps and the factors mentioned above. The null hypotheses stated that there were no relationships between the factors previously mentioned and the behavioral traps. The following subsections list each hypothesis accompanied by the statistical result for each variable to determine whether or not the hypotheses can be rejected.

$H_0$1: The null hypothesis stated that there is no relationship between a captain's age and the behavioral traps. The statistical test performed was a Point-biserial correlation. The results are as follows:

a) Loss of Situational Awareness, correlation $r = -.19$, $p = .29$

b) Neglect of Flight Planning, Preflight Inspections, and Checklists, correlation, $r = .11$, $p = .55$

c) Peer Pressure, correlation, $r = .09$, $p = .59$

d) Get-There-Itis, correlation, $r = .09$, $p = .63$

e) Unauthorized Descent Below an IFR Altitude, correlation, $r = -.25$, $p = .16$

All statistical results report p values greater than .05 and .10. Therefore, all of the null hypotheses failed to be rejected. No relationships were found between the captain's age and the behavioral traps.

$H_0$2: The null hypothesis stated that there is no relationship between a captain's flight experience (hours flown) and the behavioral traps. The statistical test performed was a Point-biserial correlation. The results were:

a) Loss of Situational Awareness, correlation, $r = -.20$, $p = .26$

b) Neglect of Flight Planning, Preflight Inspections, and Checklists, correlation, $r = .13$, $p = .46$

c) Peer Pressure, correlation, $r = .11$, $p = .54$

d) Get-There-Itis, correlation, $r = .18$, $p = .31$

e) Unauthorized Descent Below an IFR Altitude, correlation, $r = -.34$, $p = .05$

With the exception of Unauthorized Descent Below an IFR Altitude, all statistical results report a p value greater than .05. Therefore, the null hypothesis, stating there was no relationship between the captain's flight experience and the behavioral traps of Loss of Situational Awareness; Neglect of Flight Planning, Preflight Inspections, and Checklists; Peer Pressure; and Get-There-Itis failed to be rejected. The relationship between the captain's flight experience and Unauthorized Descent Below an IFR Altitude approached significance and could be investigated further.

$H_0$3: The null hypothesis stated that there is no relationship between a first officer's age and the behavioral traps. The statistical test performed was a Point-biserial correlation. The results are as follows:

a) Loss of Situational Awareness, correlation, r = -.06, p = .98

b) Neglect of Flight Planning, Preflight Inspections, and Checklists, correlation, r = .10, p = .60

c) Peer Pressure, correlation, r = -.17, p = .36

d) Get-There-Itis, correlation, r = .09, p = .97

e) Unauthorized Descent Below an IFR Altitude, correlation, r = -.12, p = .50

All statistical results report p values greater than .05 and .10. Therefore, all of the null hypotheses failed to be rejected. No relationships were found between the FO's age and the behavioral traps.

$H_0$4: The null hypothesis stated that there is no relationship between a first officer's flight experience (hours flown) and the behavioral traps. The statistical test performed was a Point-biserial correlation. The results were:

a) Loss of Situational Awareness, correlation, r = -.07, p = .69

b) Neglect of Flight Planning, Preflight Inspections, and Checklists, correlation, r = .13, p = .47

c) Peer Pressure, correlation, r = -.18, p = .31

d) Get-There-Itis, correlation, r = .00, p = .99

e) Unauthorized Descent Below an IFR Altitude, correlation, r = -.27, p = .12

All statistical results report a p value greater than .05 and .10. Therefore, all of the null hypotheses failed to be rejected. No relationships were found between the FO's flight experience and the behavioral traps.

$H_0$5: The null hypotheses stated that there is no relationship between a first officer's certification level (commercial versus airline transport pilot) and the behavioral traps. The statistical test performed was a Phi correlation. The results are as follows:

a) Loss of Situational Awareness, correlation, $r = -.05$, $p = .76$

b) Neglect of Flight Planning, Preflight Inspections, and Checklists, correlation, $r = .01$, $p = .96$

c) Peer Pressure, correlation, $r = .21$, $p = .22$

d) Get-There-Itis, correlation, $r = .10$, $p = .59$

e) Unauthorized Descent Below an IFR Altitude, correlation, $r = -.09$, $p = .62$

All statistical results report p values greater than .05 and .10. Therefore, all of the null hypotheses failed to be rejected. No relationships were found between the FO's certification level and the behavioral traps.

$H_0$6: The null hypothesis stated that there is no relationship between inclement weather and the behavioral traps. The statistical test performed was a Phi correlation. The results were:

a) Loss of Situational Awareness, correlation, $r = -.16$, $p = .35$

b) Neglect of Flight Planning, Preflight Inspections, and Checklists, correlation, $r = -.07$, $p = .68$

c) Peer Pressure, correlation, $r = .18$, $p = .29$

d) Get-There-Itis, correlation, $r = -.41$, $p = .81$

e) Unauthorized Descent Below an IFR Altitude, correlation, $r = .31$, $p = .07$

All statistical results report a p value greater than .05. Therefore, all of the null hypotheses failed to be rejected. However, the relationship between Weather and the behavioral trap called Unauthorized Descent Below an IFR Altitude was significant at the $p < .10$ level. This significance level was expected due to the fact that IFR minimum altitudes are only used when inclement weather is required to approach an airport. Therefore, no significant relationships were found between the inclement weather and the behavioral traps.

$H_0$7: The null hypothesis stated that there is no relationship between flight conditions (IMC versus VMC) and the behavioral traps. The statistical test performed was a Phi correlation. The results are as follows:

a) Loss of Situational Awareness, correlation, $r = -.17$, $p = .35$

b) Neglect of Flight Planning, Preflight Inspections, and Checklists, correlation, $r = -.43$, $p = .80$

c) Peer Pressure, correlation, $r = .13$, $p = .46$

d) Get-There-Itis, correlation, $r = .06$, $p = .73$

e) Unauthorized Descent Below an IFR Altitude, correlation, $r = .39$, $p < .05$.

With the exception of Unauthorized Descent Below an IFR Altitude, all statistical results report a p value greater than .05 and greater than .10. Therefore, the null hypotheses stating there was no relationship between flight conditions (VMC versus IMC) and the behavioral traps of Loss of Situational Awareness; Neglect of Flight Planning, Preflight Inspections, and Checklists; Peer Pressure; and Get-There-Itis failed to be rejected. The relationship between flight conditions and Unauthorized Descent

Below an IFR Altitude was likely to be significant because flight crews are expected to always conduct an instrument approach when weather conditions are IMC. Minimum IFR altitudes are only published for instrument approaches. In other words, pilots will proceed to the airport by the exclusive use of their instruments and not visually.

$H_0$8: The null hypothesis stated that there is no relationship between time of day (day versus night) and the behavioral traps. The statistical test performed was a Phi correlation. The results are as follows:

a) Loss of Situational Awareness, correlation, $r = -.10$, $p = .57$

b) Neglect of Flight Planning, Preflight Inspections, and Checklists, correlation, $r = .31$, $p = .07$

c) Peer Pressure, correlation, $r = -.24$, $p = .16$

d) Get-There-Itis, correlation, $r = .10$, $p = .95$

e) Unauthorized Descent Below an IFR Altitude, correlation, $r = .18$, $p = .29$

All statistical results report a p value greater than .05. However, the relationship between Time of Day and the behavioral trap called Neglect of Flight Planning, Preflight Inspections, and Checklists was significant at the $p < .10$ level. To investigate further, a search was begun to verify the distribution of the behavioral trap known as Neglect of Flight Planning, Preflight Inspections, and Checklists in accidents during the day versus the night. Out of the 27 accidents where this behavioral trap was found, nine of them occurred during the day while 18 happened at night. This indicates that this behavioral trap occurred twice as much during night flights. Figure 4 presents a pie chart to better understand the relationship between Time of Day and Neglect of Flight Planning, Preflight Inspections, and Checklists.

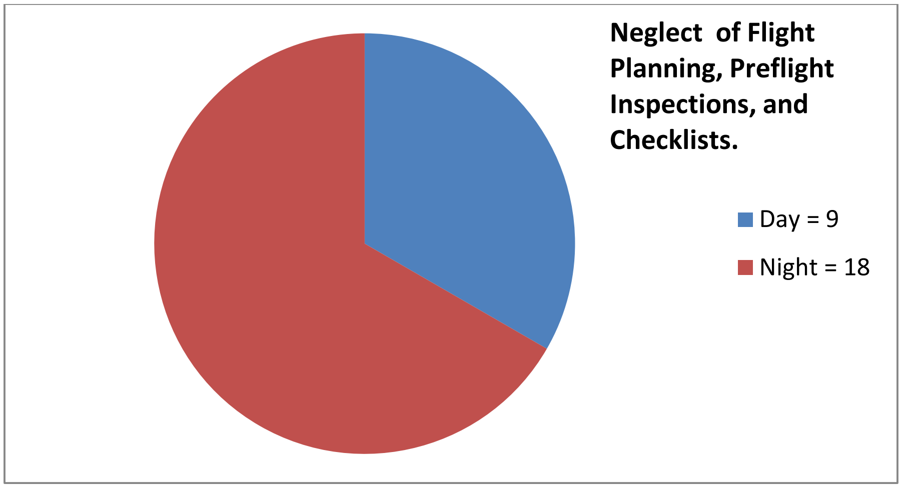

Figure 4. Occurrences of the behavioral trap called Neglect of Flight Planning, Preflight Inspections, and Checklists and Time of Day (day versus night).

No statistical result approached significance at the .05 level. Therefore, all of the null hypotheses failed to be rejected. No significant relationships were found between the time of day (day versus night) and the behavioral traps.

As indicated earlier, there was a correlation, $r = -.34$, $p = .05$, between the Captain's Flight Experience and the behavioral trap known as Unauthorized Descent Below an IFR Altitude. To explore further, a new variable combining both the experience of the Captain and First Officer was created. With this new variable called Collective Flight Experience (expressed as the sum of both crewmembers' flight time) a significant and stronger relationship was found, $r = -.35$, $p < .05$. Although this hypothesis was not presented at the beginning of the study, it was a variable worthy of additional examination because airlines could be interested in understanding how the combined experience of their flight crewmembers may relate to descending below minimums during an instrument approach in bad weather conditions. No other correlations were found to be significant between all the variables studied and the behavioral traps.

Figure 5 shows a bar graph that allows the reader to visualize this relationship by comparing the average or mean Flight experience (in hours) of the captains who descended below the IFR altitude without authorization to those who did not fall into this behavioral trap. The mean was 7,028 hours for those captains who did descend below versus the mean of 12,638 flight hours of those captains who did not.

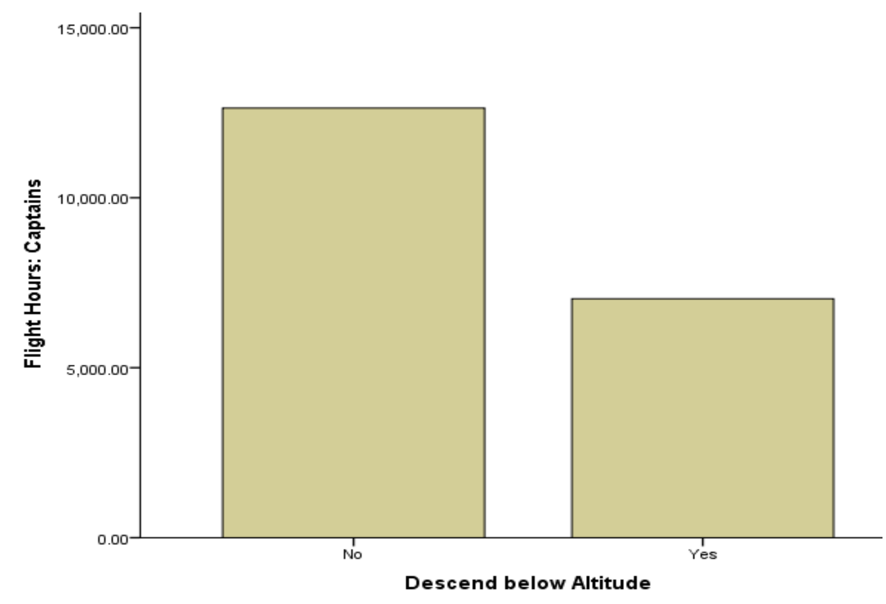

Figure 5. Bar graph comparing the flight experience (hours) means between captains who do not descend below an IFR altitude and captains that do exhibit this behavioral trap.

Figure 6 accomplishes the same data treatment with the new variable of collective flight experience. The flight experience mean of crews that do not descend below the

IFR altitude was 19,762, whereas the mean (flight hours) of those crewmembers that exhibited this behavioral trap was 10,703.

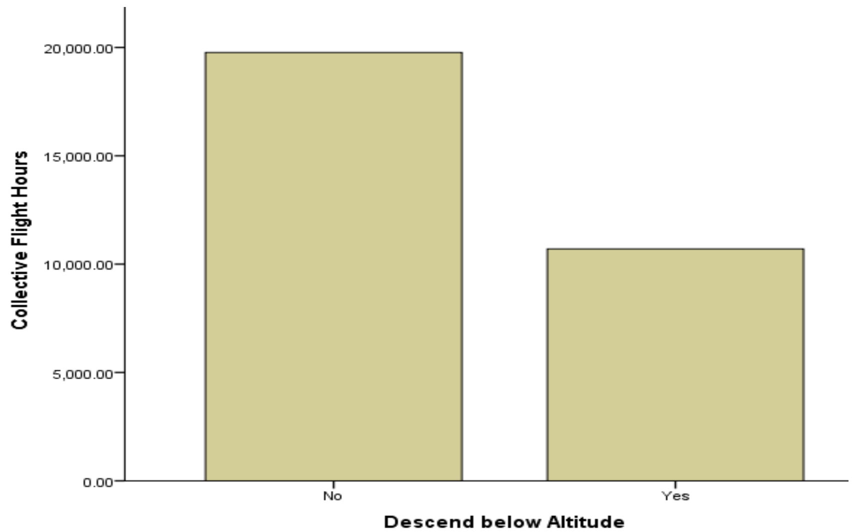

Figure 6. Bar graph comparing the collective flight experience (hours) means between flight crews who do not descend below an IFR altitude and crews that do exhibit this behavioral trap.

Table 8 summarizes the means and standard deviations for both variables, that is, Captain's Flight Experience and Collective Flight Experience and the behavioral trap called Unauthorized Descent Below an IFR Altitude. Table 9 presents the means and standard deviations of captains' and first officers' flight experiences for all other behavioral traps. Finally, Table 10 summarizes all statistical results for easy viewing.

Table 8

Means and Standard Deviations for Flight Experience of Captains and Collective Flight Experience and the Behavioral Trap of Unauthorized Descent Below an IFR Altitude

Variable	Yes Unauthorized Descent Below an IFR Altitude	No Unauthorized Descent Below an IFR Altitude
Captain Experience	M = 7, 028 hours, *SD* = 3,172 hours	M = 12,637 hours, *SD* = 5,989 hours
Collective Experience	M = 10,703 hours, *SD* = 2,910 hours	M = 19,762 hours, *SD* = 9,455hours

Table 9

Means and Standard Deviations for Flight Experience (Hours) of Captains and First Officers (FO) and All Other Behavioral Traps

Variable	Captain Experience	First Officer Experience
Yes Loss of Situational Awareness	M = 11, 107 hours, SD = 6,270 hours	M = 7, 153 hours, *SD* = 4,485 hours
No Loss of Situational Awareness	M = 13, 773 hours, *SD* = 4,851 hours	M = 6, 912 hours, *SD* = 4,829 hours
Yes Neglect of Flight Planning, Preflight Inspections, and Checklists	M = 12, 203 hours, *SD* = 6,026 hours	M = 7, 028 hours, *SD* = 3,172 hours
No Neglect of Flight Planning, Preflight Inspections, and Checklists	M = 10, 308 hours, *SD* = 5,982 hours	M = 5, 878 hours, *SD* = 3,462 hours
Yes Peer Pressure	M = 13, 216 hours, *SD* = 6,667 hours	M = 4, 880 hours, *SD* = 4,117 hours
No Peer Pressure	M = 11, 512 hours, *SD* = 5,907 hours	M = 6, 989 hours, *SD* = 4,647 hours
Yes Get-There-Itis	M = 14, 375 hours, *SD* = 6,987 hours	M = 6, 649 hours, *SD* = 5,464 hours
No Get-There-Itis	M = 11, 371 hours, *SD* = 5,809 hours	M = 6, 611 hours, *SD* = 4,512 hours

Table 10 shows a summary table of all statistical results for easy viewing. These statistical results include the Point-biserial and the Phi correlations.

Table 10

Summary of the Relationships Between Behavioral Traps and the Variables Studied

Variable	Loss of Situational Awareness	Neglect of Flight Planning, Preflight Inspections, and Checklists	Peer Pressure	Get-There-Itis	Unauthorized Descent Below an IFR Altitude
Captain Age	$r = -.19$, $p = .29$	$r = .11$, $p = .55$	$r = .09$, $p = .59$	$r = .09$, $p = .63$	$r = -.25$, $p = .16$
Captain Experience	$r = -.20$, $p = .26$	$r = .13$, $p = .46$	$r = .11$, $p = .54$	$r = .18$, $p = .31$	$r = -.34$, $p = .05$
FO Age	$r = -.06$, $p = .98$	$r = .10$, $p = .60$	$r = -.17$, $p = .36$	$r = .09$, $p = .97$	$r = -.12$, $p = .50$
FO Experience	$r = -.07$, $p = .69$	$r = .13$, $p = .47$	$r = -.18$, $p = .31$	$r = .00$, $p = .39$	$r = -.27$, $p = .12$
FO Certification	$r = -.05$, $p = .76$	$r = .01$, $p = .96$	$r = .21$, $p = .22$	$r = .10$, $p = .57$	$r = -.09$, $p = .62$
Inclement Weather	$r = -.16$, $p = .34$	$r = -.07$, $p = .68$	$r = .18$, $p = .29$	$r = -.41$, $p = .81$	$r = .31$, $p = .07$
Flight conditions	$r = -.17$, $p = .35$	$r = -.43$, $p = .80$	$r = .13$, $p = .46$	$r = .06$, $p = .73$	$r = .39$, $p < .05$
Time of Day	$r = -.10$, $p = .57$	$r = .31$, $p = .07$	$r = -.24$, $p = .16$	$r = .10$, $p = .95$	$r = .18$, $p = .29$

Qualitative Data

The following section describes, in comprehensive fashion, how each unsafe behavior is manifested within pilots of the aviation accidents. For the sake of avoiding repetition of similar pilot actions, only the most representative examples (i.e., NTSB report passages) are illustrated for the top two behavioral traps found as well as for the remaining traps of Peer Pressure, Unauthorized Descent Below an IFR Altitude, and Get-There-Itis. Because an unexpected trap had a presence in Part 121 accidents, results are also shown for the additional behavioral trap of Flying Outside the Envelope. The pilot actions representative of the behavioral traps are illustrated using tables that are immediately followed by word frequency queries called tags or word clouds.

A tag or word cloud is a visual representation of textual data highlighting the importance of the most commonly used words within a source (e.g., document, interview). Each cloud shows the most frequently used words by increasing its font size and placing those words nearer the center of the cloud. Word or tag clouds are very useful for quickly perceiving the most prominent term and its relative prominence compared to others used within a source. The relative font size indicates which words were coded most commonly throughout the sources. This last action was performed to investigate common or emerging themes within the traps themselves and the contributory factors that arose when the SMEs began to analyze the data.

Neglect of flight planning, preflight inspection and checklists. This trap was found in 27 (79%) of 34 cases. A closer examination of this behavioral trap reveals that more than one action is being accounted for. Any occasion where the pilot would deliberately or unconsciously bypass a procedure, checklist, inspection, or flight planning process, the SME team would code this behavior under this node within NVivo. Table 11 lists illustrations of pilot actions that exemplify Neglect of Flight Planning, Preflight Inspection, and Checklists found in the aviation accidents.

Table 11

Examples of Neglect of Flight Planning, Preflight Inspections, and Checklists

Accident Report	Examples
00-02	Although the airplane speed was within the target range, the airplane did not meet FedEx’s criteria for a stabilized approach because its rate of descent was greater than FedEx’s recommended 1,000 feet per minute (fpm).
01-02	Continuation of the approach to a landing when the company’s max crosswind was exceeded and use of reverse thrust greater than 1.3 engine per ratio after landing.
09-03	Investigation revealed that the flight crew did not perform several of the appropriate checklists and interrupted an emergency fire-related checklist.
11-02	Had the captain complied with standard operating procedures in response to the flap anomaly, unstabilized approach, stick shaker, and terrain awareness and warning system warning and initiated a go around maneuver, the accident likely would not have occurred.
91-02	Captain descended below 3,000 feet prior to establishing the airplane on final approach course, contrary to directions on the approach plate and established requirements.
93-02	The captain returned about 10 minutes after officer, and neither of them performed a walk around inspection of the airplane, nor were they required to do so by USAir procedures.
98-03	The captain told investigators that he did not call for emergency descend checklist but said he thought he had completed all of the items from memory.
98-03	Failure to pull the cabin air shutoff T-handle, as required by the “Cabin Cargo Smoke Light Illuminated” checklist, allowed the normal circulation of air to continue to enter the main cargo area, thereby providing the fire with a continuing source of oxygen and contributing to its rapid growth.
97-01	He said that a “norm” existed for the first officer to make hydraulic system configuration changes; he was aware that this was not standard operating practice, which assigned the task to the pilot not flying at all times. He said he conducted his cockpit according to standard operating practice, because he was new to the airplane, and he did not expect first officers to configure the hydraulic pumps.

95-01	The flight crew deviated from standard operating procedures in a number of significant ways that later affected the sequence of events leading up to the accident. Specifically, they delayed starting the second engine contrary to COA requirements to taxi on two engines during conditions that require the use of engine anti-ice. The deviation contributed to their being rushed during final preparations for takeoff. They failed to use the Delayed Engine Start Checklist, missed items on several other checklists, and did not called checklist complete.
07-05	The abbreviated briefing was contrary to company policy, and the Safety Board notes that it is prudent for pilots to fully conduct taxi briefings according to standard operating procedures.
08-02	The first officer stated that he thought that pilots were required to (and should) check landing distances with a contaminated runway. He said that he believed 4,000 feet was the required landing distance but indicated that they did not check the landing distance charts.
10-01	The reason the first officer retracted the flaps and suggested raising the gear could not be determined from the available information, these actions were inconsistent with company stall recovery procedures and training.
91-02	"I'll just do a quick procedure turn headed back in, so I'm not going to straighten out on the thing, the localizer, just teardrop and come right back around and land." The FO simply responded "OK".
94-06	The captain actively moved the power levers from the flight idle gate into the beta range for undetermined reasons. Operation of the propellers in the beta range while in flight is prohibited by the airplane flight manual.
06-01	About 1912:02, the captain transmitted a burp over the ARTCC radio frequency that would have been heard by other pilots and air traffic controllers. An unknown voice on the radio frequency responded to the captain's burp, stating, "nice tone," and the CVR recorded the accident pilot's chuckling. About 1912:53, the captain talked about deliberately dropping a flight manual on a passenger whose foot had intruded into the cockpit. The first officer engaged in banter with the captain, and both pilots used informal, nonstandard terminology during the flight.

08-01	During a post-accident interview, the first officer stated that he and the captain did the “mental math” for a 3° glideslope and that, on the basis of this calculation, they assumed that the glideslope was functioning normally. The captain further stated that the cockpit instrumentation showed the airplane on the glideslope with no warning flags. Regardless, the flight crew should not have disregarded the information provided by the controller and on the ATIS information broadcasts about the glideslope being unusable and should have used the localizer minimums for the approach.
96-07	The captain was not authorized under the COM to allow the first officer to fly the airplane. The captain told investigators that he was not familiar with the section of the COM that indicated that he was not supposed to share flying duties with the first officer.

Figure 7 shows a frequency query tag cloud illustrating the prominence of specific words within the sources analyzed: NTSB AARs and NTSB factual reports. The most frequently used words for this behavioral trap were captain, airplane, procedures, approach, and checklist.

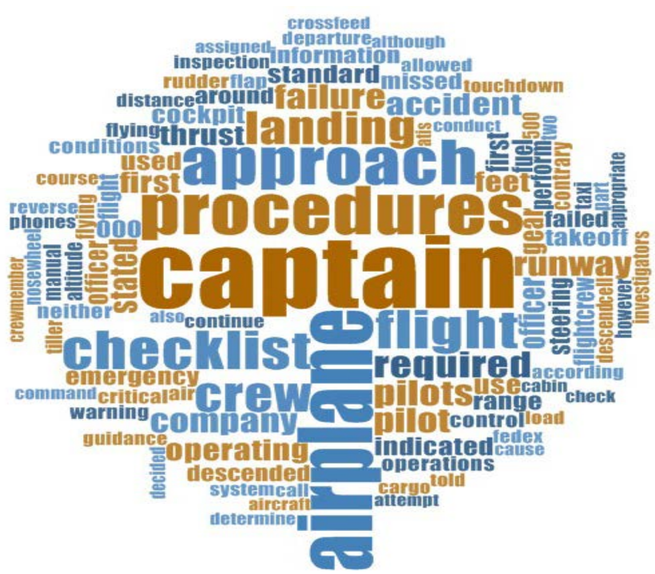

Figure 7. Tag cloud helps visualize word query for Neglect of Flight Planning, Preflight Inspections, and Checklists.

Table 12

Examples of Peer Pressure

Accident Report	Examples
94-01	Fifty feet, the first officer stated, “I’m gonna go around.” The captain stated, “No, no, no I got it” The first officer responded, “You got the airplane” As the first officer said the world “airplane”. The automatic voice said “thirty”. The captain took control and landed the airplane.
11-02	Following the application of power, the airspeed began increasing. At 0435:40, the first officer asked, “should I go around,” and the captain replied, “no,” and then stated, “keep descending.”
91-05	The captain became overly reliant on the first officer. This contributed to the runway incursion. The captain knew there was something wrong, he even questioned but acknowledged the FO’s instructions.
06-01	After hearing the weather observation, the captain commented, “we’re not getting in...we don’t have an ILS [instrument landing system].” The first officer responded, “I know...go all this [expletive] way. Well, let’s try it.” The captain responded, “yeah, we’ll try it.” About 30 seconds later, the captain said, “I don’t want to...go all the way out here for nothing tonight,” and moments later said, “I’ll be so happy when we have an ILS everywhere we go.” The first officer concurred, and the captain continued, “I thought we were gonna have it easy tonight.”
97-01	The first officer told Safety Board investigators that his goal after recognizing that the flaps were not extended was to get the captain to initiate a go-around. Thirty seconds before touchdown, the first officer stated “want to take it around?” and the captain replied “no that’s alright. * keep your speed up here about uh.” When the captain denied the first officer’s request to go around and told him to keep his speed up, the first officer did not challenge the captain’s statement. He also did not question the captain to determine his reason(s) for continuing the approach. The first officer stated that there was no time for discussion with the captain because the approach was so fast. The first officer’s failure to question the captain’s decision to continue the approach was inconsistent with the CRM training he had received that emphasized the importance of sharing doubts with other crewmembers and quickly resolving conflicts.
95-03	During the course of performing the missed approach procedure, the first officer acted, without challenge, to a command from the captain to “down, push it down.”

Figure 8 shows a frequency query tag cloud illustrating the prominence of specific words within the sources analyzed. For Peer Pressure, the most frequently coded words were captain, first, officer, stated, and airplane.

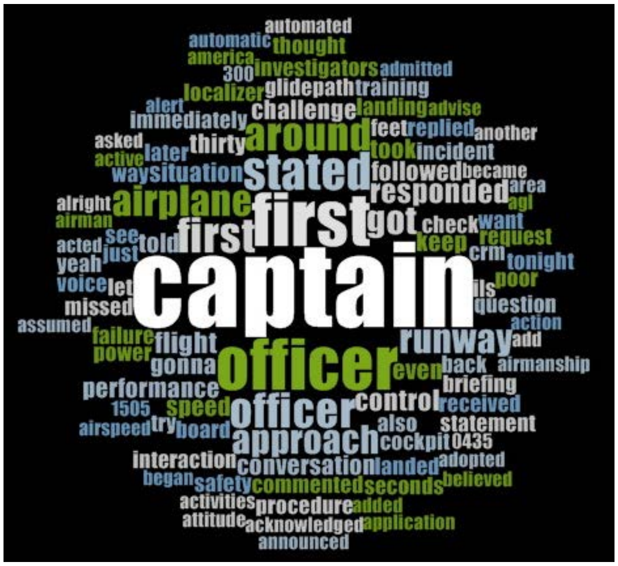

Figure 8. Tag cloud helps visualize word query for Peer Pressure.

Get-There-Itis. This trap is known in some textbooks and official FAA documents, as Get-home-itis. During Get-There-Itis the pilot's pressure comes from within (i.e., him/herself), and the obstinacy is specifically related to arriving at the destination. Table 13 lists the several illustrative instances of Get-There-Itis. This behavioral trap was found in 5 (15%) of 34 cases.

Table 13

Examples of Get-There-Itis

Accident Report	Examples
01-02	The cockpit voice recorder indicated that flight crew had discussed the weather and the needed to expedite the Approach. The captain stated “we got to get over there quick.”
95-01	The pilots failed to conduct a prestart checklist properly and, subsequently, failed to observe the illuminated light on the annunciator panel. A second opportunity to detect the status of the pitot heat knob was the annunciator panel check just before takeoff. In this case, the first officer called checklist items without the captain’s request and without using normal challenge and response procedures as the airplane was being taxied into position for takeoff. The pilots appeared to be rushed, and there is no evidence that the first officer actually observed the annunciator panel.
94-06	The captain stated “man we’re almost the speed of heat here, two sixty four or two sixty three… sixty two” he said “gosh, we gonna come down.”
94-01	The flight crew ignored the present weather conditions and continued the approach to land even during the unestablished approach, the Captain took the flight controls at the last moment when it was too late to correct or execute a go around.
05-02	The Captain fixated on landing the airplane with a disregard for any alternative course of action such as performing a go-around.

Figure 9 shows that the most frequently coded words for this behavioral trap were captain, flight, airplane, crew, approach, weather, and landing.

Figure 9. Word frequency tag cloud for Get-There-Itis.

Unauthorized Descent Below an IFR Altitude. This trap was found in 5 (15%) of 34 reports. A combination of previously named behavioral traps *Descent below the MEA* and *Duck-under Syndrome*, the concept is evidenced when a pilot descends below minimum altitudes during en route flight or an approach before obtaining visual contact with the environment, either due to a belief that there is a built-in margin of error in every approach procedure, or a refusal to admit that the landing cannot be safely accomplished and a missed approach must be initiated. Table 14 highlights several illustrations of pilot actions that exemplify Unauthorized Descent Below an IFR Altitude.

Table 14

Examples of Unauthorized Descent Below an IFR Altitude

Accident Report	Examples
14-02	The airplane continued to descend at 1,500 fpm and passed through and continued below the desired glidepath.
91-02	Captain descended below 3,000 feet prior to establishing the airplane on final approach course, contrary to directions on the approach plate and establish requirements […] captain did not have the runway environment in sight when he told the first officer to continue the approach.
06-01	The captain, while acting as pilot flying, descended below the MDA after supposedly having the approach lights in sight. The airplane struck trees and crashed just short of the runway
08-01	The MDA for the localizer (glideslope out) approach to runway 28 was 429 feet agl. No CVR evidence or post-accident interview information indicated that either crewmember had the runway environment in sight by that altitude.
96-05	The captain initially did not recognize the descent below MDA, and he failed to react immediately when he was alerted to the altitude deviation by the first officer.

Figure 10 demonstrates the most frequency coded words within this behavioral trap. These words were airplane, MDA, approach, captain, descended, and runway.

Figure 10. Word frequency tag cloud for Unauthorized Descent Below an IFR Altitude.

Loss of Situational Awareness. This trap was found in 25 (74%) of 34 cases. The FAA (2009) explains that, in extreme cases, when a pilot gets behind the aircraft, a loss of positional or situational awareness may result. The pilot may not know the aircraft's geographical location, or may be unable to recognize deteriorating circumstances. Coding this behavior under this node within NVivo involved recognizing any signs of spatial, geographic, operational, or procedural disorientation. Situational awareness includes the full appreciation of not only the aircraft's physical position in space and time but the correct procedures and the ability to plan appropriate responses to the real aircraft situation. Table 15 shows some of the most illustrative examples of Loss of Situational Awareness.

Table 15

Examples of Loss of Situational Awareness

The tag cloud represented by Figure 11 shows that the most frequently coded words during the analysis were captain, airplane, approach, first, and officer.

Accident Report	Examples
04-02	The first officer's performance was deficient in ways that appear inconsistent with characterizations of his past performance, including his failure to request flaps 30 until he was prompted to do so by the captain, his failure to say higher on the approach, his failure to maintain appropriate engine EPR settings during the approach, and his failure to respond to PAPI guidance that indicated the airplane was extremely low on the approach.
04-02	The first officer flew a concave approach, with a steeper than normal initial descend, which is characteristic of a black hole approach.
04-04	Investigation determined that pilots have generally had little exposure to, and therefore may not fully understand, the effect of large rudder pedals inputs in normal flight or the mechanism by which rudder deflections induce roll on a transport category airplane.
05-01	First officer's failure to properly apply crosswind landing techniques to align the airplane with the runway centerline and to properly arrest the airplane's rate of descend (flare) before the airplane touched down.
01-02	An unidentified voice in the cockpit stated, "a…. we' are off course." In a post-accident interview, the first officer stated that he thought the airplane was stabilized until about 400 feet above the field elevation, at which point the airplane drifted to the right.
05-02	A review of the first officer's medical record from his personal psychiatrist revealed that, in July 2001, he began seeing the psychiatrist for treatment of various anxiety-related symptoms. The psychiatrist prescribed alprazolam to treat the first officer condition. Common side effects of alprazolam include drowsiness and light-headedness.
05-02	The captain failed to take control of the airplane when he notices the incorrect approach procedures form the First Officer.
11-02	Flight crew's failure to monitor and maintain a minimum safe airspeed while executing an instrument approach in icing conditions, which resulted in an aerodynamic stall at low altitude.
91-05	About ½ minute later, the first officer stated, "guess we turn here." When the captain expressed some doubt about this left turn, the first officer replied, "Near as I can tell. Man, I can't see out here."
91-05	A lack of proper crew coordination, including a virtual reversal of roles by the DC9 pilots, which led to their failure to stop taxing their airplane and alert ground controller of their positional uncertainty in a timely manner before and after intruding onto the active runway.
93-02	He believed that the snow had "all but stopped" and was more concerned about the amount of vehicular traffic, such as sweepers and plows, than he was about the snowfall.
94-01	The flight crew ignored the present weather conditions and continued the approach to land even during the unestablished approach, the Captain took

	the flight controls at the last moment when was too late to correct or execute a go around.
06-01	Captain asked, “what do you think?,” and the first officer responded, “I can’t see [expletive].” About 2 seconds later, as the airplane continued to descend, the captain stated, “yeah, oh there it is. Approach lights in sight.” Almost immediately, the GPWS annunciated “two hundred” feet.
97-03	The captain gradually reduced the engine power because he perceived a need to slightly increase the airplane’s rate of descent; however, the descent rate increased beyond what the captain likely intended to command.
97-01	According to the first officer, the captain reached up to the overhead panel as the GPWS was alerting. The captain did not recall doing this and stated that he had interpreted the GPWS alerts as a high sink rate warning. The Captain decided to continue to land from an unstable approach without realizing the gear was up and flaps were up. The result was a wheels up landing at the Houston airport.
06-03	About 1 minute later, the first officer stated, “something’s messed up with this thing,” and, at 0039:07, he asked “why is this thing?” At 0041:21, the first officer stated that the control wheel felt “funny.” He added, “feels like I need a lot of force. It is pushing to the right for some reason. I don’t know why...I don’t know what’s going on.” The first officer then repeated twice that it felt like he needed “a lot of force.” The CVR did not record the captain responding to any of these comments.
10-01	The reason the captain did not recognize the impending onset of the stick shaker could not be determined from the available evidence but that the first officer’s tasks at the time the low-speed cue was visible would have likely reduced opportunities for her timely recognition of the impending event; the failure of both pilots to detect this situation was the result of a significant breakdown in their monitoring responsibilities and workload management.
92-05	Failure of the crew to recognize and recover from an unusual attitude after experiencing spatial disorientation or an attitude indicator failure during the second missed approach.
01-02	The first officer asked the captain whether he wanted to accept "a short approach" and "keep it in tight." The captain answered, "yeah, if you see the runway 'cause I don't quite see it." The first officer stated, "yeah, it's right here, see it?" The captain replied, "you just point me in the right direction and I'll start slowing down here."
06-03	The flight crew did not monitor the fuel quantity gauges or respond properly to the airplane’s changing handling characteristics.
91-09	Flight crew's failure to detect and remove ice contamination from the wings was a causal factor in this accident.

Figure 11. Word frequency tag cloud for Loss of Situational Awareness.

Flying Outside the Envelope. Flying Outside the Envelope can range from the pilot assuming an inappropriate level of performance capability of a particular aircraft, intentionally exceeding aircraft limits assuming there is a margin of safety built into the aircraft, or an overestimation of the pilot's flying skills that causes the flight to exceed the aircraft's structural and/or aerodynamic limits. In any case, the pilot allows or causes the aircraft to exceed its design limits. See Table 16 for occurrences of this behavioral trap which was found in 7 (21%) of 34 accidents.

Table 16

Examples of Flying Outside the Envelope

Accident Report	Examples
04-04	The probable cause of this accident was the in-flight separation of the vertical stabilizer as a result of the loads beyond ultimate design that were created by the first officer's unnecessary and excessive rudder pedal inputs.
01-02	Continuation of the approach to a landing when the company's max crosswind was exceeded and use of reverse thrust greater than 1.3 engine per ratio after landing.
05-01	The excessive vertical and lateral forces on the right main landing gear during the landing exceeded those that the gear was designed to withstand and resulted in the fracture of the outer cylinder and the collapse of the right main landing gear.
06-03	The captain's calculations showed the airplane outside of acceptable weight and balance limits.

Figure 12 shows us the word frequency tag cloud for this behavioral trap. The most commonly found words were airplane, landing, captain, accident, approach, company, and exceeding.

Figure 12. Tag cloud for Flying Outside the Envelope.

Additional Contributing Factors Such as Airline Management, CRM issues, and Fatigue. During the qualitative analysis, the SMEs discovered that many accidents were also the result of factors outside of the five behavioral traps under study. These factors included airline management, CRM issues, and fatigue. Airline management causes are shown in Table 17. CRM issues are shown in Table 18. Any examples of fatigue are presented in Table 19. A word frequency query within NVivo explored these issues further. Thus, figures 13, 14, and 15 display the word frequency tag clouds for each contributing factor, respectively.

Table 17

Examples of Airline Management as a Contributing Factor

Accident Report	Examples
00-02	According to flight plan and release documents, the airplane was dispatched to ANC with left engine thrust reverser inoperative.
05-02	Executive airline's manager of training and standards stated that, before the accident, the company did not teach its pilots bounced landing recovery techniques. The manager also stated that he would not want to conduct bounced landing recovery training in the simulator because it was very difficult to demonstrate.
93-03	Maintenance personnel use of an inappropriate manual engine star procedure, which led to the uncommanded opening of the left engine air turbine starter valve, and subsequent left engine fire.
93-03	The checklist deviations and other pilot procedural deficiencies noted by the FAA during a special inspection, which included numerous en route inspections about one month before the accident, suggest that the problems identified in this accident regarding improper checklist procedures were systemic at COA. If pilots fail to adhere to procedures during enroute inspections by FAA inspectors, they most likely behave in a similar manner when no inspector is present.
96-07	The first officer stated that when he and his classmates questioned the absence of the [manual], the Flight Safety International simulator instructors informed them that ValuJet wanted them to use the QRH "like a Bible" for abnormal procedures. The first officer indicated that he and his classmates stopped their first simulator session and called the company to get an official determination as to what guidance they should use for abnormal and emergency procedures during routine flight operations; he stated that ValuJet management advised them to use the QRH instead of the manual.
91-09	The DC-9 Operations Manuals were basically developed by Ryan from the airplane's previous owner's Operations Manuals, and certain purported Ryan practices were not incorporated into them. The requirement to conduct an exterior inspection of the airplane at intermediate stops was one of those practices not incorporated. In fact, the preflight inspection requirement in the Ryan DC-9 manual clearly indicated that exterior inspections were required only on originating flights or after the airplane had been left unattended.

Figure 13. Tag cloud for airline management contributing factors.

The most commonly used words found in the word frequency query for airline management issues were airplane, procedures, company, and inspection.

Table 18

Examples of CRM Issues as Contributing Factors

Accident Report	Examples
05-01	Proper CRM was not present. The captain never made a comment regarding the deviations or helped the First Officer before landing.
01-02	The first officer indicated, in a post-accident interview that “there was no discussion of delaying or diverting the landing” because of the weather.
11-02	The captain commented about the flap problem, neither crewmember discussed a procedure or checklist to address it. The flight crew’s poor communication and failure to follow operating procedures regarding flap asymmetry, showed the lack of proper Crew Resource Management and Negligence as a Flight Crew during the approach.
14-02	The captain changed the autopilot mode from the previously briefed profile approach to vertical speed mode, initially setting the vertical descend rate to about 700 fpm, then increasing it to 1,000 fpm; however, he did not brief the first officer about the autopilot mode change
91-05	A lack of proper crew coordination, including a virtual reversal of roles by the DC9 pilots, which led to their failure to stop taxing their airplane and alert ground controller of their positional uncertainty in a timely manner before and after intruding onto the active runway.
98-03	The captain did not adequately manage his crew resources when he failed to call for checklist or to monitor and facilitate the accomplishment of required checklist items.
06-01	After hearing the weather observation, the captain commented, “we’re not getting in... we don’t have an ILS [instrument landing system].” The first officer responded, “I know...go all this [expletive] way. Well, let’s try it.” The captain responded, “yeah, we’ll try it.” About 30 seconds later, the captain said, “I don’t want to...go all the way out here for nothing tonight,” and moments later said, “I’ll be so happy when we have an ILS everywhere we go.” The first officer concurred, and the captain continued, “I thought we were gonna have it easy tonight.”
97-01	The first officer told Safety Board investigators that his goal after recognizing that the flaps were not extended was to get the captain to initiate a go-around. Thirty seconds before touchdown, the first officer stated “want to take it around?” and the captain replied “no that’s alright, keep your speed up here about uh.” When the captain denied the first officer’s request to go around and told him to keep his speed up, the first officer did not challenge the captain’s statement. He also did not question the captain to determine his reason(s) for continuing the approach. The first officer stated that there was no time for discussion with the captain because the approach was so fast. The first officer’s failure to question the captain’s decision to continue the approach was inconsistent with the CRM training he had received that emphasized the importance of sharing doubts with other crewmembers and quickly resolving conflicts.

92-05 The flight engineer brought to the captain's attention the airspeed deviation but the captain never corrected; neither the first officer nor the flight engineer called for a go-around.

08-01 Safety Board concludes that, when the captain called for a go-around because he could not see the runway environment, the first officer should have immediately executed a missed approach regardless of whether he had the runway in sight. The Safety Board further concludes that, when the first officer did not immediately execute a missed approach, as instructed, the captain should have reasserted his go-around call or, if necessary, taken control of the airplane. During a post-accident interview, the captain stated that he thought a transfer of control to perform a missed approach at a low altitude might have been unsafe.

95-03 During the course of performing the missed approach procedure, the first officer acted, without challenge, to a command from the captain to "down, push it down."

94-01 The flight crew ignored the present weather conditions and continued the approach to land even during the unestablished approach, the captain took the flight controls at the last moment when it was too late to correct or execute a go around.

06-01 Captain asked, "what do you think?," and the first officer responded, "I can't see [expletive]." About 2 seconds later, as the airplane continued to descend, the captain stated, "yeah, oh there it is. Approach lights in sight." Almost immediately, the GPWS annunciated "two hundred" feet.

92-05 Shortly thereafter, the cockpit voice recorder (CVR) revealed comments by the captain on the first officer's flying technique, such as "If you're gonna fly that slow you gotta have more flaps," and "[unintelligible words] still don't have enough flaps for this speed...add power...you're not on the glidepath...bring it up to the glidepath," and "You're not even on the [expletive] localizer at all." At 03 13, the captain stated "Okay, we're gonna have to go around...cause we're not anywhere near the localizer...anywhere near it."

93-04 Inexplicably, the first officer reacted to the stick shaker by immediately deciding that the captain should be flying and abandoning control of the airplane to the captain without warning or proper coordination.

06-03 About 1 minute later, the first officer stated, "something's messed up with this thing," and, at 0039:07, he asked "why is this thing?" At 0041:21, the first officer stated that the control wheel felt "funny." He added, "feels like I need a lot of force. It is pushing to the right for some reason. I don't know why...I don't know what's going on." The first officer then repeated twice that it felt like he needed "a lot of force." The CVR did not record the captain responding to any of these comments.

10-01	The reason the captain did not recognize the impending onset of the stick shaker could not be determined from the available evidence but that the first officer’s tasks at the time the low-speed cue was visible would have likely reduced opportunities for her timely recognition of the impending event; the failure of both pilots to detect this situation was the result of a significant breakdown in their monitoring responsibilities and workload management.
92-05	Failure of the crew to recognize and recover from an unusual attitude after experiencing spatial disorientation or an attitude indicator failure during the second missed approach.
06-03	The flight crew did not monitor the fuel quantity gauges or respond properly to the airplane’s changing handling characteristics.
91-09	Flight crew's failure to detect and remove ice contamination from the wings was a causal factor in this accident.

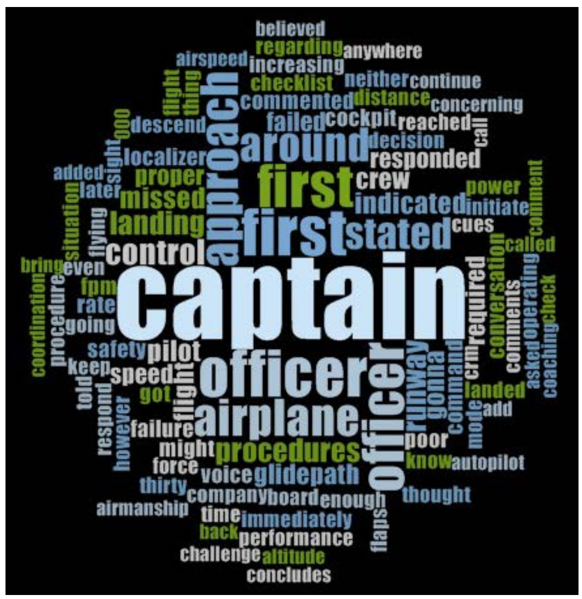

Figure 14. Word frequency tag cloud for CRM issues.

The words most commonly coded within CRM issues were captain, first, officer, airplane, and approach.

Table 19

Examples of Fatigue as a Contributing Factor

Accident Report	Examples
06-01	The pilots were flying their sixth flight of the day and had flown about 6 hours and 14 minutes in 14 hours and 31 minutes of duty time when the accident occurred. CVR recorded a yawn on the first officer's channel.
10-01	Each pilot made an inappropriate decision to use the crew room to obtain rest before the accident flight.
92-05	There were several obvious "misspeaks" by both pilots (drift vs. crab, and 25 degrees flaps vs. 23 degrees flaps) that may have indicated some degree of fatigue. Notwithstanding the fact that the crewmembers of flight 805 were air cargo operations veterans and had adapted to these types of disrupted work/sleep schedules many times, this experience did not make them immune to the possible adverse effects of fatigue or their ability to function effectively.
08-01	The captain reported that he received only about 1 hour of sleep during the night before the accident and, as a result, asked the first officer to be the flying pilot for the flight.

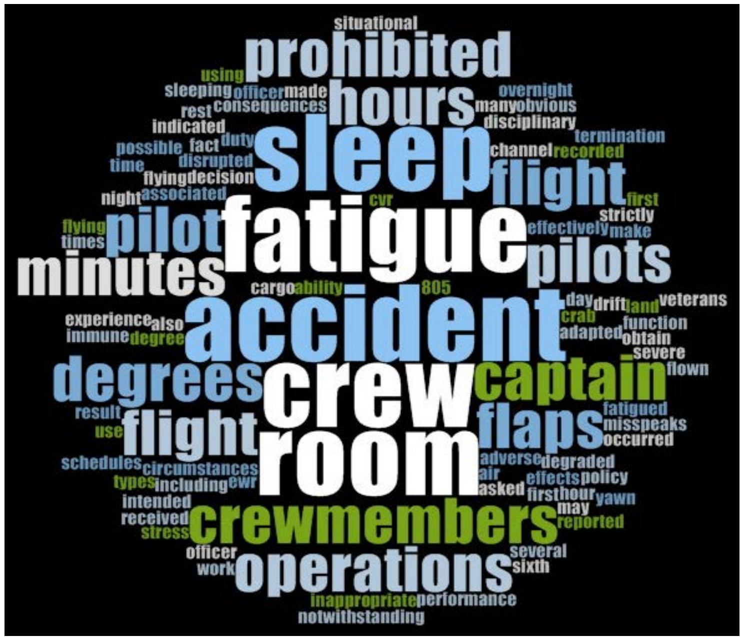

Figure 15. Tag cloud for fatigue as a contributing factor.

The most commonly coded words within fatigue were accident, fatigue, sleep, crew, and room.

Relational Analyses. Similar to the quantitative statistical analysis in which few significant relationships were found between the behavioral traps and the various factors associated with the accident, no strong or even moderate associations were established using NVivo for the relational analysis and the qualitative component of the study.

Figure 16 displays a Hierarchy chart, in the form of a tree map, when all behavioral traps are taken into consideration and mixed with the contributory factors. A tree map is a diagram that shows hierarchical data as a set of nested rectangles of varying sizes. The chart uses size to represent the amount of coding at each node. Rectangle size indicates amount, for example, the number of nodes coded or amount of coding references. Larger areas display at the top left of the chart; smaller rectangles display toward the bottom right. This figure can help us visualize the prevalence of all issues within the qualitative analyses of the accidents. The top three concerns related to the accidents were Neglect of Flight Planning, Preflight Inspections, and Checklists; Loss of Situational Awareness; and CRM issues.

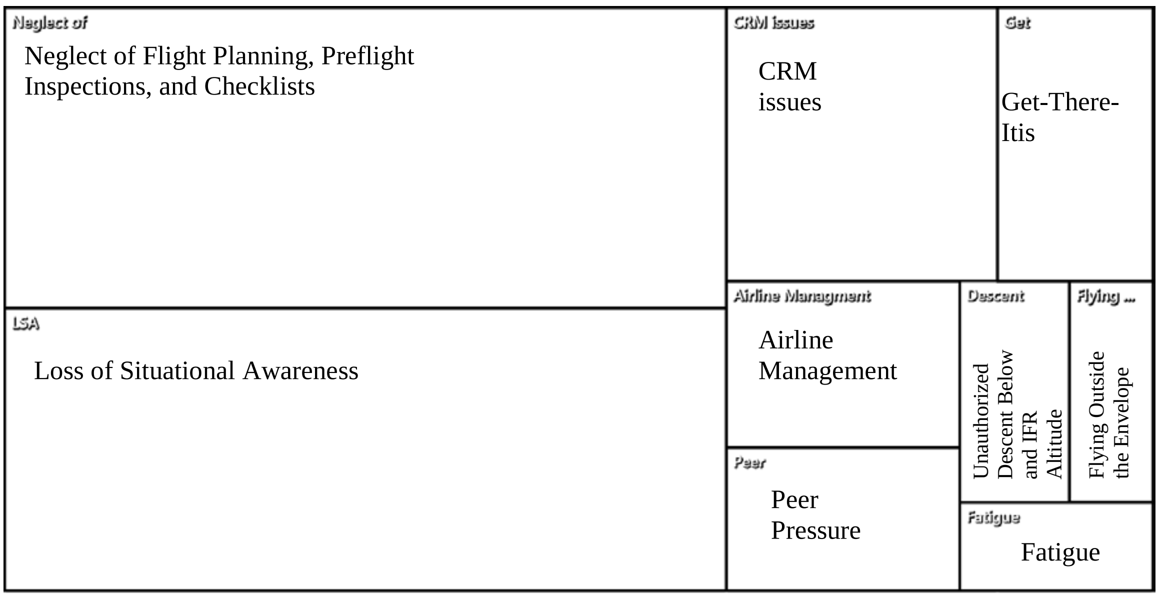

Figure 16. Word tree indicating the prevalence of all factors considered during the analysis of the NTSB accidents.

CHAPTER V

DISCUSSIONS, CONCLUSIONS, AND RECOMMENDATIONS

Discussions

The current study was aimed at discovering how and which behavioral traps were present in Part 121, and what relationships, if any, existed between the behavioral traps and factors such as pilot age, pilot flight experience, weather, flight conditions, time of day, and the first officer certification level.

In general, behavioral traps were found in all (100%) of crew-related accidents analyzed by SMEs (fatal and non-fatal). This finding aligns with Wetmore and Lu (2005a; 2005b; 2006) who reported that hazardous attitudes were part of 86% of fatal accidents with Invulnerability cited as the most predominant attitude. Invulnerability is the hazardous attitude where pilots believe accidents happen to others and not to them. This behavior is analogous to two of the behavioral traps studied: Unauthorized Descent Below an IFR Altitude and Neglect of Flight Planning, Preflight Inspections, and Checklists.

Flight Experience. A moderate correlation, $r = -.34$, $p = .05$, was found between the Captain's Flight Experience and the behavioral trap known as Unauthorized Descent Below an IFR Altitude. The sample size for the study was small (N=34). This correlation coefficient would be significant if there was a larger N. This relationship means that as experience or flight time increased, the chance of descending below an IFR altitude decreased. This finding seems intuitive because generally pilots with more experience should be able to identify and mediate their own unsafe behaviors. The results also agree with Wetmore and Lu (2005b), where pilot experience correlated with a reduction of hazardous attitudes and with Rebok et al. (2005) where flight experience was negatively associated with violations in commuter and air taxi pilots. The results do not agree with Bazargan and Guzhva (2011) where, unexpectedly, pilots with fewer flight hours were least likely to be involved in fatal accidents. However, their study, as is the case with the majority cited within the literature review, was focused on the GA pilot.

According to Dismukes et al. (2007), low time first officers increase operational risk. However, this study found that first officer experience had no significant relationship to any of the behavioral traps.

To further explore the effect of flight experience, a new variable was created that combined the experience of the captain and first officer. With this variable called Collective Flight Experience (expressed as the sum of both crewmembers' flight time) a significant relationship was found with the behavioral trap known as Unauthorized Descent Below an IFR Altitude, $r = -.35$, $p < .05$. Although this hypothesis was not presented at the beginning of the study, it was a variable worthy of additional examination because airlines could be interested in understanding how the combined experience of their flight crewmembers may relate to descending below minimums during an instrument approach in bad weather conditions. This finding could inform individuals in flight management positions as to how best to combine flight crewmembers when flying to destinations with inclement weather where an instrument approach procedure is expected.

It is worth mentioning that this new variable, combining the collective flight experience among the flight crewmembers, was also investigated to see if any relationships existed with the other behavioral traps. No significant relationships were found.

Age. Cook (2002) found that an increase in age correlated with a decrease in hazardous behavior. However, this current study concurs with Wetmore and Lu (2005b) where age did not correlate to hazardous attitudes. In the present study, no relationship was found between age and behavioral traps. This finding is the result of focusing the research on strictly Part 121 airplane and crew-related operations, as opposed to the previously mentioned (Cook) study where the aim was Part 135 and 121 fixed-wing and/or rotorcraft operations. According to Drinkwater and Molesworth (2010), older pilots are more willing to engage in risky behaviors. In addition, Li et al. (2005) and Bazargan and Guzhva (2011) have established that older pilots are also more likely to be involved in accidents (fatal and non-fatal). However, the focus of these last three research endeavors, as opposed to the present study, was on the GA pilot.

Finally, the relationship between Time of Day (day versus night) and the behavioral trap called Neglect of Flight Planning, Preflight Inspections, and Checklists, was significant at the $p < .10$ level, $r = .31$, $p = .07$. Essentially, as the value set for Time of Day increased to that of Night (i.e., 2), the chance of this behavioral trap would also increase. It has been established that the desire to complete a flight increases as pilots near their destination (Dismukes et al. 2007; Kern, 1998). This finding suggests that as the day expires and other factors such as fatigue and the desire to complete the flight as planned come into play, pilots are more willing to disregard procedures. No other correlations were found to be significant between all the variables studied and the behavioral traps (including the additional behavioral trap found called Flying Outside the Envelope).

Qualitative Analysis

Neglect of Flight Planning, Preflight Inspections, and Checklists was the most widespread behavioral trap. This unsafe behavior was identified in 79% of the accidents studied. Loss of Situational Awareness came in a close second place with representation in 74%. Peer Pressure was found in 18% of accidents while the traps of Get-There-Itis and Unauthorized Descent Below an IFR Altitude were both present in 15% of the accidents.

Neglect of Flight Planning, Preflight Inspections, and Checklists. A review of the NTSB excerpts presented in the Results section confirms many prior discoveries in that pilots, even air carrier aviators, might have a general disregard for rules or procedures and underutilize many resources at their disposal (Dismukes et al., 2007; Goglia, 2015; Rapp, 2015; Veillette, 2006). The findings of this study also align with Klinect et al. (2001) where willful violations were present in 35% of regular air carrier flights observed and a pilot study conducted by Velazquez et al. (2015) where Neglect of Flight Planning, Preflight Inspections, and Checklists was the most dominant trap.

If airline flight operations are so highly *scripted* (Dismukes et al., 2007), why are pilots unwilling to follow rules and established procedures? An explanation is that Part 121 pilots may experience a phenomenon called *habitual noncompliance* (Goglia, 2015). Highly qualified pilots who routinely fly together under repetitive circumstances may constantly betray their own FOM processes. The NTSB and Goglia advocate the installation of cockpit cameras to help ensure that pilots conduct themselves under established protocols (Rapp, 2015).

Loss of Situational Awareness. The leading behavioral trap in fatal accidents was Loss of Situational Awareness. This is not surprising because the concept involves more than knowledge of the aircraft's geographical or spatial position. It also comprises the pilot's consciousness of the different elements affecting the overall status of the aircraft. These elements include weather, aircraft condition, crewmember state, and mission or flight progress. If passengers are being transported, they also form part of the expansive definition of situational awareness (FAA, 2008). Thus, any sign of spatial, geographic, operational, or procedural disorientation would be coded under Loss of Situational Awareness. As opposed to the previous behavioral trap of Neglect of Flight Planning, Preflight Inspections, and Checklists under Loss of Situational Awareness, the crew may not be cognizant of danger. Sadly, this may explain it leading the prevalence of behavioral traps under fatal accidents.

Peer Pressure. Human beings have a natural desire to conform to others, to be accepted (Kern, 1998). As stated earlier, Peer Pressure can be verbal, or non-verbal, obvious or subtle, intentional or unintentional, and its origin may be personnel or organizational (Kern, 1998). In all but one case examined during this study, it was the captain of the flight who was the source of peer pressure for the first officer. A look at all the word frequency queries associated with the behavioral traps studied revealed that the word *Captain* is within the top five most commonly found words. It is evident that first officers are automatically disengaging or suppressing their own arguments for the sake of acceptance. This lack of assertiveness is further explained in a following section. Finally, although there were instances of managerial factors that contributed to the accidents, no overwhelming evidence was found that airlines provided organizational pressure to crews of the ill-fated flights.

Get-There-Itis. As mentioned earlier, as the flight progresses, the pilots' desire to continue gets stronger (Dismukes et al. 2007; Kern, 1998). This tendency was exemplified in Table 10 where four out of five cases of Get-There-Itis occurred during the approach and landing phase. This finding confirms what Dismukes et al. (2007) called *plan continuation bias*, a failure of the crew to "discontinue an approach when it becomes inappropriate or dangerous to do so" (p. 280). Interestingly, the word frequency tag cloud for Get-There-Itis, and for five out of the six behavioral traps studied, suggests that behavioral traps occur mostly in the approach and landing phase of flight because the words *approach or landing* both appear as top common words. This is not surprising considering that the majority of aviation accidents, including commercial, occur during the approach and landing phase of flight.

Unauthorized Descent Below an IFR Altitude. A look at Figure 9 reveals that the word *MDA* or minimum descent altitude was among the most frequently found within the documented sources. This finding initiated a search back into the NTSB excerpts found in Table 11 to find out whether or not all instances of Descending Below an IFR

Altitude were indeed associated with non-precision approaches or approaches where no vertical guidance is available. The conclusion was a resounding yes. All cases of this behavioral trap were associated with non-precision approaches. These types of instrument approaches add complexity to the approach and landing phase of flight, more so if the approach was originally a precision approach and due to technological difficulties the crew was left with a different approach at the last minute.

CRM Issues. As indicated by the word tree in Figure 15, the third overall factor contributing to the accidents was lack of CRM practices. This finding is not surprising considering the most prevalent behavioral trap across all cases was Neglect of Flight Planning, Preflight Inspections, and Checklists. In addition, there was a presence of other CRM-rescinding traps such as Peer Pressure, Unauthorized Descent Below an IFR Altitude, Get-There-Itis, and the additional discovered trap of Flying Outside the Envelope.

CRM is the epitome or ultimate expression of teamwork between flight crewmembers prior, during, and after a flight. Good CRM practices are predicated on following checklists, SOPs, conducting good preflight action, and engaging in proper flight planning to prepare for unexpected events during flight. However, as seen throughout this study, crews are falling under habitual noncompliance, and first officers are demonstrating a lack of assertiveness. Broome (2011) believes pilots are rejecting CRM.

Though CRM has evolved through many generations to the point that crews today are aware that the best strategy is to manage threats and errors, it looks as if CRM training lacks an important component called *attitude management* training. Attitude management is defined as “the ability to recognize hazardous attitudes in oneself and the willingness to modify them as necessary” (FAA, 2009, p. G-1). Unfortunately, the FAA CRM training guidance (AC 120-51e) does not provide any direction on attitude management training nor does it provide any information about hazardous attitudes, behavioral traps, or the various cognitive biases pilots are confronted with.

LOFT has been the preferred CRM training method for years. However, the results of this study confirm many findings (Dismukes et al. 2007; Wagener & Ison, 2014) suggesting that this scenario-based training tool may not be applied effectively and continuously. Dismukes et al. (2007) cites inadequate knowledge or experience provided by training and/or guidance as a factor in 37% of NTSB accidents between 1991 and 2001. In other words, pilots were not given adequate instruction about problems known by some of the sectors of the industry to exist or, “found themselves in challenging situations for which they had received training, but the experience received from that training was of inadequate fidelity to the actual situation, inadequately detailed, or incomplete” (Dismukes et al., 2007, p. 298).

Conclusions

Although the quantitative portion of this study revealed there was a lack of significance in nearly every variable studied (at the $p < .05$ level), this dissertation accomplished many firsts and contributed considerably to the understanding of how negative behaviors – specifically behavioral traps – are present in airline operations. No published study had tackled behavioral traps in air carrier operations until now.

Secondly, this dissertation revises Jeppesen's (2014) categorization of behavioral traps among GA, instrument-rated, and commercial pilots. For example, it was discovered that the behavioral trap of Flying Outside the Envelope is not exclusive to GA pilots; airline pilots also exceed airplane operational tolerances. Finally, the study also makes public how flight crews might be practicing CRM and tells the story of the captains' preeminence. A look at all the word frequency queries associated with the behavioral traps revealed that the word *Captain* is within the top five most commonly found words. How effective is CRM if it is evident that first officers are automatically disengaging or suppressing their own arguments for the sake of acceptance?

To begin, behavioral traps were present in all 14 CFR Part 121 accidents where crew error was a causal or contributing factor of accidents between 1991 and 2013. The top two behavioral traps were Neglect of Flight Planning, Preflight Inspections, and Checklists and the trap known as Loss of Situational Awareness which was the leading behavioral trap in fatal accidents.

As shown in the previous chapter, there were no significant relationships between the behavioral traps of Neglect of Flight Planning, Preflight Inspections, and Checklists, Loss of Situational Awareness, Get-There-Itis, and Peer Pressure, and factors such as age, time of day, flight conditions, first officer experience, or first officer certification level. However, a moderate correlation, $r = -.34$, $p = .05$ was found between the captain's flight experience and the behavioral trap known as Unauthorized Descent below an IFR Altitude.

Flying Outside the Envelope should be included in the commercial category of behavioral traps (Jeppesen, 2014) among commercial, instrument-rated, and GA pilots due to its presence in 21% of accidents analyzed. With the exception of Peer Pressure, all other behavioral traps mainly occur in the approach and landing phase of flight. This finding coincides with the phase of flight responsible for the majority of commercial aviation accidents. Finally, Unauthorized Descent Below an IFR Altitude was completely related to non-precision approaches or instrument approaches without vertical guidance in the approach design.

Recommendations

Recommendations for Further Study. Because this study focused on 14 CFR Part 121 crew-related accidents, any future studies can focus on Part 135 commercial and air taxi operators. In addition, while the information contained in the National Aeronautics and Space Administration's ASRS accounts is self-reported by the pilots, valuable information can be retrieved from these incident reports to continue to understand pilot unsafe behaviors whether they are defined as hazardous attitudes or behavioral traps.

Because Neglect of Flight Planning, Preflight Inspections, and Checklists was the top behavioral trap, additional research should focus on the reasons for customary noncompliance and pilot motivation. While the NTSB and Goglia are advocating for cockpit cameras to be installed in air carrier operations, perhaps a better approach would be to scientifically review the flight data recorders. This assessment should be routinely accomplished by airlines in a non-punitive way (Rapp, 2015).

The relationship between the captain's flight experience and Unauthorized Descent Below an IFR Altitude approached significance and should be investigated further using a larger sample size.

Recommendations for Industry. The creation of CRM and like programs does not always guarantee the absence of unsafe pilot behaviors (Cook, 2002). However, effective crew performance depends on both technical proficiency and interpersonal skills. One of the main objectives behind the FAA's CRM training has always been to focus on crew member attitude and effectual teamwork. Because the FAA believes attitudes can be changed or modified through training (1991), from a standpoint of accident prevention, education and training focused on the top behavioral traps would likely prove to have the highest payoff. This recommendation is especially true considering that Neglect of Flight Planning, Preflight Inspections, and Checklists is the prevailing trap. Additional focus should be placed on: (1) the captain's authority and ability to identify and mediate unsafe behaviors, (2) the first officer's ability to be assertive and combat peer pressure, and (3) the approach and landing phase. The lack of first officer assertiveness and preeminence of the captains should be addressed in training, and even investigated in future studies. This former action could be done through cognitive debiasing training and/or scenario-based training during LOFT sessions where additional focus is on the interpersonal skills of flight crewmembers.

Because there was a moderate relationship between the captain's flight experience and the behavioral trap called Unauthorized Descent Below an IFR Altitude and a significant relationship between collective (flight crew) experience and the same behavioral trap, individuals in flight operational management positions should be cautious when assigning crews with low flight time to missions where inclement weather is a factor.

Many behavioral traps exist in airline operation. The understanding of pilot attitudes and their role in team dynamics or impact on CRM requires further study. Finally, attitude management training is recommended in CRM training.

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APPENDIX A

Permission to Conduct Research

From: Gabriel, Teri A.
Sent: Friday, September 11, 2015 3:51 PM
To: Velazquez, Jonathan
Cc: Brady, Tim; Wiggins, Michael E; Gabriel, Teri A.
Subject: IRB 16-032 Exempt - Behavioral Traps in...

Dear Jonathan Velazquez,

The Chair of the IRB has reviewed your protocol application titled, ***Behavioral Traps in Crew-related Part 121 accidents*** and has determined that it meets the requirement for **exemption**. You may proceed with your research.

Attached is the Determination Form for your records - best of luck in your endeavors.

Teri Gabriel, MPA, CRA
Human Protections Administrator & Research Analyst
Research & Graduate Studies
600 S Clyde Morris Blvd
Daytona Beach, FL 32118
386.226.7179
Teri.gabriel@erau.edu

APPENDIX B

Data Collection Device

Tally Sheet
BT = behavioral trap
PIC = Pilot-in-command (captain)
SIC = Second-in-command (first officer)

NTSB report #	Primary BT	Secondary BTs	Flight conditions	Weather	Day or Night	SIC Certification Level	PIC Age	PIC Flight time	SIC Age	SIC Flight time

Notes on accident chain of events:

APPENDIX C

Ground Lesson: Behavioral Traps

Objective(s): To familiarize the subject matter expert (SME) with the Federal Aviation Administration (FAA) harmful pilot attitudes known as Behavioral Traps. To develop the SME's skill in recognition of pilot behaviors that are indicative of behavioral traps. Finally, to be able to properly evaluate flight situations, using accident reports, and identify pilot conduct revealing of behavioral traps.

Methods: Lecture, audio visuals, and demonstration

Materials: 4 FAA videos, 2 National Transportation Safety Board (NTSB) aviation accident case studies, 1 Flight Safety Foundation (FSF) case study, whiteboard, markers, highlighters, PowerPoint presentation, data collection sheets, and notebook for memoing.

References: FAA Flight Instructor Handbook, FAA Risk Management Handbook, and Jeppesen Flight Instructor textbook.

Presentation:

Topics:

1. Behavioral Traps (Definitions and Descriptions)
    a. Neglect of Flight Planning, Preflight Inspections, and Checklists

i. The pilot, without justification relies on short or long-term memory, regular skills, and familiar routes instead of established procedures.
ii. The pilot does not use checklists adequately.
iii. The pilot does not comply with company standard operating procedures (SOPs).
iv. The pilot does not perform a complete preflight inspection.
v. The pilot does not devote time to proper flight planning or preflight preparation.
vi. The pilot does not use all resources to become familiar with the available information concerning the flight (weather, known ATC delays, etc.).

b. Loss of Situational Awareness (SA)

i. The pilot allows events or situations to control pilot action.
ii. The pilot is in a constant state of surprise at what happens next.
iii. The pilot behaves in a reactive manner; loses the ability to anticipate the next event. The pilot is not proactive.
iv. Pilot does not know the aircraft's geographical position.
v. Pilot is unable to recognize deteriorating circumstances.
vi. The pilot is unable to cope or deal with changes in a given situation.
vii. The pilot exhibits poor workload management and consistently gets behind the airplane.

viii. The pilot loses overall awareness.

c. Peer Pressure

i. Rather than evaluating a situation objectively, the pilot's decision-making is based on the emotional response to :

1. coworkers
2. passengers
3. other pilots

d. Get-There-Itis

i. The pilot is fixated on the original goal or destination combined with a disregard for any alternative course of action.

ii. The pilot wants to satisfy a schedule.

e. Unauthorized descent Below an IFR altitude

i. The pilot descends below the minimum altitude during the en route phase (MEA).

ii. Where no MEA exists, and the flight is conducted via direct routes, the pilot descended below the Minimum Off-route Altitude (MORA, as defined by the Jeppesen) or Off-route Obstruction Clearance Altitude (OROCA, as defined by the FAA).

iii. The pilot descends below the minimum altitude during an instrument approach (e.g., DA, MDA).

2. Data collection sheet (See Appendix B)
3. Qualitative Approach for Analysis: using the data collection sheet

a. Coding and categorizing behaviors within the NTSB reports = the FAA behavioral traps will be used as *a priori* codes. In other words *selective coding* will take place (SME will code systematically with respect to the FAA concepts).

b. Memoing = SME will record the thoughts and ideas as he reads the NTSB reports. This helps make sense of the data. SME can memo on the separate sheet of paper or, if the PDF program allows, the SME can insert comments as he goes through the analysis of the documents.

c. Integrative sessions = the coding and memoing will be cross-compared with the other SMEs that share the same NTSB report. This final act will lead to new observations and/or linkages which could result in revisions in the data collection process. It will also assist in reliability for the study.

4. Demonstration exercise example using the data collection sheet – Case Study 1

    a. The behavioral traps will be identified using the NTSB Aviation Accident Report (AAR) with an emphasis on the Probable Cause Section for the Primary Behavioral Trap.

    b. Any secondary behavioral traps will also be identified using the full information in the NTSB report AAR.

Practice: Case Study 2 (Accident to be determined)

Assessment:

1. Written Test covering the concepts, that is, the behavioral traps applicable to the FAR Part 121 airline environment.
2. Practical Test: Case Study 3 (Accident to be determined).

a. coding (individually; each SME)

b. memoing (individually; each SME)

c. integrative sessions (collectively; all SMEs)

Completion Standards: The lesson is complete when:

1. The SME demonstrates understanding of the FAA-defined behavioral traps by passing the written examination test with a minimum score of 80% (the instructor will review each incorrect response to ensure complete understanding).
2. The SME is capable of identifying and categorizing the behavioral traps using NTSB Aviation Accident Reports. This includes proper use of the data collection sheet.

APPENDIX D

Short Biographies of SMEs

1. **Omar Carle** is Captain of a CE 650 and SD3 at MN Aviation in San Juan, Puerto Rico. MN Aviation is a 14 CFR Part 135 company that conducts cargo and passenger charter flights in the Americas. Omar has been very active in the aviation industry for more than 13 years. He has experience in almost every aviation field, from Part 61/141 Ground/Flight Instructor to Part 135/121 commercial line pilot. Previous to MN Aviation, Omar worked as a first officer for American Eagle Airlines, a 14 CFR Part 121 organization and was Assistant Chief Flight Instructor at the Inter American University of Puerto Rico.

   Omar holds a B.S. in Aircraft Systems Management (Professional Pilot) from the Inter American University of Puerto Rico - Bayamon Campus. He is a Certified Flight Instructor (CFI) Certified Flight Instructor Instrument (CFII), and Multi-engine Instructor (MEI), an Airline Transport Pilot with airplane multi-engine category and holds four Type Ratings. Omar's passion for teaching has evolved in the cockpit taking advantage of the CRM environment to motivate, teach, and provide skills to young pilots, who he personally considers as "Captains in Training".

2. **Kevin Roman** is a CRJ 200/701/900 Captain at PSA Airlines. Before he became a pilot for the aforementioned 14 CFR Part 121 air carrier, Kevin worked as a flight and ground instructor at Florida Institute of Technology (FIT). During his

tenure at FIT, Roman worked with international students, specifically in the Turkish Airlines program where students were prepared from their Private Pilot certificate to the Commercial Pilot certificate in an intensive airline-like training.

Kevin Roman holds a B.S. in Professional Pilot from the Inter American University of Puerto Rico. He is an ATP with airplane multi-engine category and CL-65 type rating, Commercial Pilot with airplane single engine category, and a Certified Flight Instructor (CFI, CFII, and MEI).

3. **Oswart A. Mora** is an Adjunct Professor and Chief Flight Instructor at the School of Aeronautics of the Inter American University of Puerto Rico. The School of Aeronautics conducts flight training under 14 CFR Part 141. In 2013, Mora was instrumental in achieving FAA Part 141 certification for the School's flight operations. He is also a Flight/Ground Instructor and Captain in MN Aviation San Juan P.R. under 14 CFR Part 135. Oswart Mora is very much active within the local aviation community. He frequently collaborates with the Organization of Black Aerospace Professionals providing voluntary courses to motivate young kids towards a career in aviation.

   Oswart holds a Master in Business Administration Degree in Finance from the Inter American University of Puerto Rico – Metropolitan Campus and a B.S. in Professional Pilot and a B.S. in Aviation Management, both from the Inter American University of Puerto Rico - Bayamon Campus. He is a Certified Flight

Instructor (CFI, CFII, and MEI), commercial pilot helicopter, and an ATP Multi-engine.

4. **Pablo J. Ortiz** is a First Officer for Southwest Airlines. Prior to Southwest, Pablo worked for Republic Airways Holdings as a First Officer flying the Embraer 145. Later, Mr. Ortiz became a Captain and Check Instructor flying the Embraers 145, 170, and 190. Prior to his professional airline career, Pablo worked as a flight instructor for Middle Tennessee State University (MTSU) and the Inter American University of Puerto Rico and was promoted as the Assistant Chief Flight Instructor at both institutions.

   Pablo Ortiz possesses a B.S. in Professional Pilot from the Inter American University of Puerto Rico. He is an Airline Transport Pilot with multi-engine and single-engine category and B-737, EMB 145, and EMB 170/190 type ratings. In addition, he is a Gold Seal Certified Flight Instructor (CFI, CFII, MEI) and Advanced Ground Instructor (AGI).